Department of Transportation
Federal Aviation Administration

for Civilian Airports and Air Force Bases

AD A 123890

Federal Aviation Administration
Office of Environment and Energy
Washington, D.C. 20591

United States Air Force
Engineering Services Laboratory
Tyndall Air Force Base, Florida 32403

G.F. Eberle
M.D. Steer

December 1982

FAA Report No. FAA-EE-82-21
USAF Report No. ESL-TR-82-33

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No. 19 FAA-EE-82-21 (FAA) ESL-TR-82-33 (USAF)	2. Government Accession No. AD-A123 890	3. Recipient's Catalog No.
4. Title and Subtitle 18 19 Air Quality Procedures for Civilian Airports and Air Force Bases		5. Report Date DEC. ~~November 12~~, 1982
		6. Performing Organization Code
		8. Performing Organization Report No.
7. Author(s) G. F. Eberle and M. D. Steer		
9. Performing Organization Name and Address Greiner Engineering Sciences, Inc. One Village Square Baltimore, Maryland 21210		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFA01-81-C-10045
		13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Office of Environment and Energy Washington, D.C. 20591		
		14. Sponsoring Agency Code

15. Supplementary Notes

This report was sponsored jointly by the Federal Aviation Administration and the United States Air Force.

16. Abstract

A review of air quality assessment procedures for a number of projects involving Federal funds has shown a wide variety of procedures to accomplish similar tasks. While some of these procedures were the result of different requirements by various states, there existed for most projects certain areas of procedural similarity. The purpose of this handbook is to define and quantify these areas in order to simplify the task of preparing environmental assessments.

Because certain air quality assessment procedures are similar for civilian and military installations (both assessments may involve coordination with the same local air quality agency), the USAF and the FAA decided to jointly develop uniform procedures applicable to both agencies.

The heart of the procedures described in this handbook are flow diagrams which identify the extent to which detailed analysis may be required. These flow diagrams identify the interfaces with the numerous agencies involved in the air quality assessment process and what data or methodology could be used. The flow diagrams contain screens or thresholds below which further analysis may not be needed. Where dispersion modeling is required, simplified models and tabular look-up charts are referenced.

Section I of the handbook provides general information relating to the basis for environmental assessment and the projects that usually require such analysis. Section II provides step-by-step descriptions and flow diagrams of the air quality assessment process, including steps on state requirements. Section III discusses the various steps involved in preparing an inventory of emission sources and in describing the atmospheric dispersion of these sources. Section IV provides some sample problems, while Section V includes a glossary of terms and an annotated reference list.

17. Key Words Air Quality Assessment Airport Emissions Dispersion Modeling	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	152	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

INTRODUCTION

PURPOSE AND CONTENT OF THIS HANDBOOK

The requirement for air quality assessment had its origin in national legislation relating to the environment and its protection. Federal agencies have subsequently developed procedures for air quality investigations relating to their programs. The purpose of this handbook is to provide additional guidance, procedures, and methodologies to be used in satisfying the requirements of the National Environmental Policy Act (NEPA). It is intended for use by FAA personnel, U.S. Air Force personnel and/or airport sponsors involved in the preparation and/or review of environmental assessments and/or subsequent environmental documents. This handbook will also serve as a reference/textbook for the FAA's Environmental Training Course.[1]

Section I of this handbook presents general background information regarding the basis for air quality assessment, projects requiring such assessment, and the major pollutants.

Section II provides a detailed step-by-step description and flow chart of the tasks involved in the air quality assessment process, including information on state assessment requirements.

Section III explains the various technical steps involved in preparing an emission inventory and describes the range of air pollution modeling techniques.

Section IV demonstrates the application of the assessment procedures to specific airport/air base actions through the development of sample scenario's and resultant evaluations.

Section V provides a glossary of basic terms and a listing of reference material.

---

[1] FAA Course #12000, presented at the FAA's Aeronautical Center in Oklahoma City, Oklahoma.

SECTION I

SECTION I: BACKGROUND

BASIS FOR THIS HANDBOOK

This section summarizes the historical and legal background associated with the air quality assessment procedures established for Federal Aviation Administration and U.S. Air Force actions.

National Environmental Policy Act (NEPA) of 1969, As Amended

NEPA is the basic national charter for the protection of the environment. It sets forth national goals, establishes policy, and provides the means for the execution of the policy. Several sections of NEPA relate to general environmental assessment by agencies of the Federal Government:

- Section 102(2)(A):

  "...[all agencies of the Federal Government shall] utilize a systematic interdisciplinary approach which will insure the integrated use of the natural and social sciences...in planning and decision-making..."

- Section 102(2)(B):

  "...[all agencies of the Federal Government shall] identify and develop methods and procedures...which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making..."

- Section 102(2)(C):

  "...[all agencies of the Federal Government shall] include in every...report on major Federal actions significantly affecting the quality of the human environment, a detailed statement ...on the environmental impact of the proposed action..."

All Federal agencies were charged with reviewing their traditional missions and policies in light of the national environmental objectives, and developing specific criteria and methods of identifying actions likely to require assessment and impact statement preparation. It is the responsibility of each Federal agency to evaluate the impacts of a proposed agency action in their decision-making process prior to the authorization of the expenditure of Federal funds. This process is influenced through coordination with State and local authorities, and while the assessment procedures are frequently determined on a case by case basis, they generally involve the steps outlined in this document.

Subsequent to NEPA [and the associated regulations from the Council on Environmental Quality (CEQ)], the FAA and U.S. Air Force developed environmental procedures which apply the national policy to the specific range of potential projects or actions with which each agency is involved.

<u>Airport and Airway Improvement Act of 1982</u>

Section 509 of this act contains several environmental-related criteria which must be met for approval of certain airport projects: airport location, major runway extension, or new runway location. Project applications for these types of actions can not be approved unless the Governor (or his designee) certifies that "there is reasonable assurance that the project will be located, designed, constructed or operated so as to comply with applicable air and water quality standards."

<u>Clean Air Act Amendments of 1977</u>

In addition to NEPA, the Clean Air Act Amendments of 1977 constitute another piece of national legislation relating to the environment which ultimately affects assessment procedures, but within the specific impact area of air quality.

One of the key elements of the Clean Air Act Amendments and the assessment process is the State Implementation Plan (SIP). Section 110 of the Act requires each State to adopt a plan which provides for implementation, maintenance, and enforcement of the primary and secondary national ambient air quality standards in that state. Section 176(C) states in part that no Federal agency shall engage in, support in any way or provide financial assistance for, license or permit, or approve any activity which does not conform to the SIP.

A second key element of the legislation which relates to the assessment process is found in Section 309: "Policy Review." This section

in part provides the Environmental Protection Agency (EPA) with the authority to review and comment in writing on the air quality impacts of major Federal actions to which NEPA [Section 102(2)(C)] applies. The coordination mechanism for involvement with air quality agencies at various levels is an integral part of the assessment process as referenced herein.

In an effort to develop air quality criteria to protect against potential adverse effects, the legislation established two levels of air quality standards. These are primary standards which are designed to protect human health and secondary standards which are established to protect human welfare. Table I-1 presents the current National Ambient Air Quality Standards. It should be noted here that under provisions of the Clean Air Act, states were also given the option of establishing their own ambient air quality standards. However, standards adopted by the states must be either identical to or more stringent than the Federal standards.

Federal Aviation Administration's Environmental Orders

Since the passage of NEPA, the development of the FAA's specific environmental assessment guidance has been a dynamic one. Agency and court interpretations, increasing public interest, the availability of new technical evaluation methods, related legislation for specific impact areas, and the CEQ Regulations have all required that FAA's environmental procedures be continually reviewed and modified accordingly over the years.

Three basic FAA orders now exist which provide environmental guidance for the assessment of FAA actions and projects:

- FAA Order 1050.1C (December 20, 1979) - provides agency-wide policies and procedures for considering environmental impacts, and preparing Environmental Impact Statements and Findings of No Significant Impact (FONSI).
- FAA Order 5050.4 (March 21, 1980) - provides instructions and guidance for preparing and processing the environmental assessments of <u>airport development</u> proposals.
- FAA Order 1050.15 - provides instructions on the form and content of FAA environmental documents (non-airport actions).

Table I-1
National Ambient Air Quality Standards

Pollutant	Primary[a]	Secondary[a]
Particulate Matter		
Annual geometric mean	75	60
Maximum 24-hour concentration[b]	260	150
Sulfur Oxides		
Annual arithmetic mean	80 (.03 ppm)	60 (.02 ppm)
Maximum 24-hour concentration[b]	365 (.14 ppm)	260 (.10 ppm)
Maximum 3-hour concentration		1,300 (.5 ppm)
Carbon Monoxide		
Maximum 8-hour concentration[b]	10 (9 ppm)	Same as primary
Maximum 1-hour concentration[b]	40 (35 ppm)	
Photochemical Oxidants		
Maximum 1-hour concentration[b]	235 (.12 ppm)	Same as primary
Hydrocarbons		
Maximum 3-hour (6:00-9:00 a.m.) concentration[b]	160 (.24 ppm)	Same as primary
Nitrogen Dioxide		
Annual arithmetic mean	100 (.05 ppm)	Same as primary
Lead		
Three-month average	1.5 $\mu g/m^3$	Same as primary

[a] All measurements are expressed in micrograms per cubic meter ($\mu g/m^3$) except those for carbon monoxide, which are expressed in milligrams per cubic meter (mg/m^3). Equivalent measurements in parts per million (ppm) are given for the gaseous pollutants.

[b] Not to be exceeded more than once a year.

The latter two orders contain detailed guidance on the actual technical assessment of individual impacts, including air quality. When it is determined that an FAA action may have an air quality impact, the appropriate instructions in the orders should be reviewed along with the procedural and technical discussions in this handbook.

United States Air Force Regulation (AFR) 19-2

AFR 19-2 describes the Environmental Impact Analysis Process (EIAP) for all Air Force organizations and activities, the Air Force Reserve, and the Air National Guard[1]. The EIAP provides the process for decision-making based on an understanding of the potential environmental consequences of an action and its alternatives.

The regulation implements NEPA, the CEQ Regulations, and Department of Defense Directive 6050.1. It contains the policy, procedures, and responsibilities for the EIAP and provides guidance on EIS's, FONSI's, and Categorical Exclusions. The regulation highlights the environmental planning functions (EPF) at the various levels of command, including the completion of several key environmental analysis forms.

---

[1] AFR 19-2, Environmental Impact Analysis Process (EIAP) 1 September 1982, 47 CFR 38524-38530.

PROJECTS WITH AIR QUALITY IMPACT

The FAA's environmental orders provide some guidance as to the types of projects requiring air quality assessment. The basic consideration in this determination is whether the project or actions will introduce new aircraft operations or create an increase in operations. Closely related to the aircraft sources is the associated ground traffic that may be generated by the action.

In addition to these basic mobile sources on the airport, some airport development may include provisions for or enlargement of large point sources such as power plants. Therefore, the types of projects which may require some form of air quality assessment generally include the following:

- A new airport;
- A new runway;
- A runway extension;
- Other physical airside improvements increasing capacity;
- Major new construction or expansion of passenger handling or parking facilities; and
- Airport power plant construction or expansion.

The construction and operation of a totally new airport facility would generally constitute a new pollution source in the region. Just the magnitude of this type of project may require some level of assessment. Other airport actions such as the construction of additional runways or taxiways may also produce greater airport activity. A runway extension may allow a new mix of aircraft to operate at a particular airport, thereby introducing new emission characteristics.

Increases in aircraft operations not only result in greater emissions from aircraft but also may require improvements or additions to the landside access system, parking areas, and curbside layout to accommodate the associated levels of surface traffic. Since traffic emissions can contribute to total airport emissions, any improvements to passenger handling and access/parking facilities may require assessment of their potential air quality impacts.

Finally, the large scale airport facilities may require the construction or expansion of power plant facilities. If so, then these point sources could be included in an air quality assessment.

Other airport actions that do not affect operations, ground traffic, or power plants and do not increase airport-related emissions are generally not subject to assessment.

Air Force actions which may require air quality assessment generally include aircraft operations, i.e., a unit conversion from one aircraft to another; low level operations in a designated area; or a mission realignment. In the case of a "bed-down," where many new aircraft are assigned to a base, the assessment may be extended to include base auto emissions. Air quality assessment may be required for heating plant conversion projects.

GENERAL ASSESSMENT PROCEDURES

Air quality assessment procedures for airport sources are more complex than those for individual sources since they may involve a number of different line, area, and point sources. The assessment procedures generally involve the initial calculations of an emission inventory of airport sources and then, if necessary, the calculation of concentrations produced from individual sources.

In many cases, aircraft engine emissions, produced along runways and taxiways, have to be evaluated; thus requiring a knowledge of aircraft engine types and emission factors. The basic operational unit used in this evaluation is the individual aircraft landing and takeoff cycle (LTO). This cycle is made up of the aircraft's various operating modes: arrival, taxi, idle, taxi, departure.[2] The assessment procedures require a knowledge of the number of LTO's per aircraft type during the averaging time and an estimate of the average time in each mode. While this generalized cycle may not reflect characteristics of a particular scenario, its use will save time and effort if concentrations are estimated to be low.

In addition to aircraft, associated motor vehicle traffic utilizing the airport's access roads comprise another line source. An evaluation of these sources also requires knowledge of emission factors and operating units, in this case, the average daily traffic and the peak hour traffic. This part of the evaluation basically follows the procedures for general highway emission evaluations as outlined in the Federal Aid Highway Program Manual (FHPM) Volume 7, Chapter 7, Section 9 or EPA guideline documents.[3]

The airport and its operation may also create area sources of emissions. These may include apron areas where aircraft and service vehicles operate or parking lots/structures for motor vehicles. Assessment procedures would require data regarding apron/parking lot configuration and size, and vehicle usage patterns.

Large point sources are not generally associated with airport operations. The most commonly occurring point sources at airports are

---

[2] See References 8 and 14 in the Annotated Reference List in Section V.

[3] See Reference 15 in the Annotated Reference List in Section V.

fuel storage or handling facilities, or heating plants. During fuel transfer, emission may be generated by spillage or evaporation of hydrocarbons from the fuel being handled. Evaluation involves knowledge of fuel types and operating characteristics.

The completion of an air quality assessment requires an understanding of the basic considerations and procedures of the air quality analysis. These would include the recognition of the major pollutants, particularly those related to mobile sources; their emission rates; and if necessary, the concentrations produced from emission sources.

MAJOR POLLUTANTS

Air pollutants are defined as contaminants in the atmosphere. There are both man-made and natural sources of these pollutants. Many man-made air pollutants are a direct result of the incomplete combustion of fuels, including coal, oil, natural gas and gasoline.

The major air pollutants for which there are national ambient standards are:

- Carbon Monoxide (CO);
- Hydrocarbons (HC);
- Oxides of Nitrogen (NO_x);
- Sulfur Oxides (SO_x);
- Total Suspended Particulate (TSP);
- Photochemical Oxidants; and
- Lead.

Due to the diverse nature and form of the major pollutants, a general classification of these compounds into one of two classes--either "primary" or "secondary"--has been developed. Primary pollutants are those chemical materials which are emitted directly into the atmosphere by a source. CO, HC, SO_2, NO and TSP are all considered primary pollutants. Secondary pollutants are those formed in the atmosphere as a result of reactions such as hydrolysis, oxidation and photochemistry. NO_2 and the entire class of photochemical oxidants comprise the largest part of this classification.

Carbon Monoxide

Carbon Monoxide (CO) is the most widely distributed and the most commonly occurring air pollutant. The total emissions of CO to the atmosphere exceed those of all other air pollutants combined. It is a colorless, odorless, tasteless gas, slightly lighter than air. Although quite flammable, it does not support combustion. Most atmospheric CO is formed by the incomplete combustion of organic materials uses as fuels (i.e., coal, wood, gas, etc.)

Hydrocarbons

Hydrocarbons (HC) are compounds whose molecules include atoms of hydrogen and carbon. They exist in our atmosphere predominantly in a gaseous state. Various compounds classified as hydrocarbons include methane (CH_4), olefins, aldehydes, ketones, and terpenes.

Hydrocarbon pollutants originate primarily from the incomplete combustion of fuels, particularly the more volatile fuels such as gasoline, and from the use of hydrocarbons as process raw materials such as solvents. The major man-made sources are gasoline-powered vehicles, but also include other types of vehicles such as aircraft. Man-made stationary sources which emit hydrocarbons primarily, include petroleum and petrochemical operations and solvent usage, with some contribution from waste burning.

Hydrocarbons are not, by themselves, a health hazard; rather, it is their reaction with other pollutants and sunlight which produces photochemical smog. This condition reduces visibility and can cause eye irritation and an aggrevation of respiratory problems.

Oxides of Nitrogen

Of the various oxides of nitrogen known to exist, only two, nitric oxide (NO) and nitrogen dioxide (NO_2) are emitted into the atmosphere in significant quantities. NO is formed during all high-temperature atmospheric combustion processes in a spontaneous chemical reaction between the nitrogen and oxygen in the air. NO_2 forms when NO reacts with atmospheric oxygen (O_2). When both chemical compounds occur, they are referred to collectively as total oxides of nitrogen (NO_x).

Nitric oxide (NO) is formed when combustion takes place at a high enough temperature to cause a reaction between the nitrogen and oxygen in the air. Temperatures this high are reached only in efficient combustion processes or when combustion takes place at high pressure. These conditions are primarily found in automobile or aircraft engine cylinders, electric power plants, and other very large energy-conversion processes. Nitric oxide, which is relatively harmless, is the form generally emitted into the atmosphere. It will, at varying times, oxidize to nitrogen dioxide (NO_2), which is a considerably more toxic gas. This oxidation process is a product or by-product of a number of industries including fertilizer and explosives manufacturing.

Sulfur Dioxide

Sulfur dioxide (SO_2) is the most prevalent of the many chemical compounds of sulfur and oxygen. It is a relatively stable, nonflammable, nonexplosive, colorless gas. SO_2 can act as either a reducing agent or as an oxidizing agent, and it can react with materials in the air to form sulfur trioxide, sulfurous acid, and sulfate salts. Sulfur trioxide, (SO_3) reacts very rapidly with water vapors to produce sulfuric acid (H_2SO_4), while a similar reaction of sulfurous acid (H_2SO_3) with oxygen in the air produces the same corrosive compound.

Sulfur dioxide is generated during the combustion of any sulfur-bearing fuel and by many industrial processes that use sulfur-bearing raw materials. Combustion of fuels accounts for over 90 percent of all SO_2 emitted. This is due to the relatively high sulfur content of some bituminous coals and residual fuel oils, and to the very large amounts of these fuels consumed in this country and around the world as a source of power. Smelting of metallic ores and oil refinery operations are the major sources of industrial process SO_2 emissions. Other sources include coke procesing, the manufacture of sulfuric acid and refuse incineration.

Photochemical Oxidants

This is a large category which includes the products of the photochemical reaction of hydrocarbons with the oxides of nitrogen. They are colorless, toxic gases, the most commmon of which are ozone (O_3); formaldehyde (HCHO); peroxyacyl nitrate ($CH_3[CO]OONO_2$), commonly abbreviated PAN; acrolein (CH_2CHCHO); and peroxybenzoyl nitrate (PBzN). There are no physical sources of photochemical oxidants per se. As noted, they are formed in the atmosphere as a result of photochemical reactions between hydrocarbons and oxides of nitrogen.

Total Suspended Particulates

As related to control technology, total suspended particulates (TSP) are defined as any material (except uncombined water) that exists as a solid or liquid in the atmosphere or in a gas stream under standard conditions of temperature and pressure (68 degrees F [20 degrees C] and 760 mm of Hg.).

It is important for purposes of definition, that "standard conditions" for particulate matter be included. This is due to the fact that, under certain conditions, some compounds no longer exist as solids or liquids, but are instead condensed in the ambient atmosphere, thereby losing their aerosolize characteristics. Particles discharged into the

atmosphere may be in the form of fly ash, soot, dust, fog, fumes, etc. An important characteristic of suspended particles is their size distribution. Particles released from man-made sources are generally in the size group one to ten microns (μ).

The sources of TSP are as varied as their forms. Nearly every industrial, commercial, and domestic location in the world emits particulate matter in either a solid or liquid state. The combustion of fuels produces particulate matter due to the ash content and various additives such as lead, which are burned. Grinding and other mechanical processes are also significant sources of particulate matter. Natural sources include ocean salt, volcanic ash, wind erosion, forest fire smoke and ash, and plant and seed pollen.

Lead

Lead (Pb) is a heavy metal which occurs in the atmosphere as lead oxide aerosol or lead dust. Approximately 1.3 million tons of lead are used by industry annually to produce batteries, pigments and anti-knock compounds added to gasolines. More than 90 percent of air borne lead is due to automotive exhausts resulting from the use of tetraethyl lead in gasoline to prevent engine knock.

METEOROLOGY

Meteorology is that science dealing with the phenomena of the atmosphere, especially weather and weather conditions. With respect to air quality evaluations, meteorology is one of the prime factors which must be considered along with the pollutants themselves.

The science of meteorology is made up of many fundamental subdisciplines, each one influencing pollutant dispersion in its own way. The sum of these parameters are defined as the meteorological conditions of a given region or area. The presentation of parameters and terms which follows is intended to familiarize the reader with the basic concepts of meteorology.

Wind

"Wind" refers to air movements either in the horizontal plane (parallel to the earth's surface) or in the vertical plane (perpendicular to the earth's surface). It is considered a primary meteorological factor in the life cycle of an air pollutant. Winds are defined by both their direction and their speed. These two parameters are also the primary meteorological factors that affect the transport and dispersion of atmospheric pollutants. Wind direction determines the path of the pollutant transport and is identified by the direction <u>from</u> which the wind blows.

Wind speed, to some extent, will determine the concentration of pollutants in a given volume of air. In general, higher wind speeds create more favorable conditions for dilution and dispersion of the pollutants.

Mixing Depth

Mixing depth (or height) is the height above the surface through which relatively vigorous vertical mixing occurs. Meteorologists use this term to qualitatively represent the dispersion capacity of the atmosphere. On overcast days, the height of the tops of the cumulus clouds can be used as an estimate of the upper limit of the mixing depth. On clear days, usually a sharp demarcation, caused by a temperature inversion, exists between the mixed turbid air below and the clean air above. Temperature inversions often form the boundary which marks the limit of ground-based mixing.

There are significant differences in seasonal averages for mixing depth at most locations. During the summer daylight hours, the

mixing depth may reach several thousand feet. In the winter, less heat is received from the sun and the mixing depth may be as low as a few hundred feet. The mixing depth will also vary in the course of a day.

Temperature

The temperature of the earth is related to the intensity of the solar radiation. The diurnal (daily) changes in solar radiation set up a cycle of heating and cooling of the atmospheric boundary layer. The importance of ambient air temperature is reflected primarily in its distribution with altitude, which is described under Atmospheric Stability.

Atmospheric Stability

The tendency of the atmosphere to either enhance or suppress vertical motion affects the concentration of air pollutants. A stable atmosphere tends to increase pollutant concentrations while an unstable atmosphere tends to minimize pollutant concentrations. Stability is related both to the vertical temperature structure (the decrease in temperature with increasing height) and wind shear (variation of horizontal wind speed and direction with height). However, the vertical temperature structure is generally used as the major measure of stability.

EMISSION FACTORS

Two definitions are important when discussing quantities of emissions from mobile sources. "Emission rate" is the rate at which pollutants are emitted from the exhaust system of a given vehicle. "Emission factor" refers to a statistical average of emission rates which is used to characterize the aggregate effect of many vehicle emissions.

Many variables, which vary with time and locality, affect the computation of the emission factors. These include operating mode, application of control devices, vehicle mix by type, vehicle age distribution and operating speeds. Some of these variables apply to both aircraft and highway vehicles and some only to highway vehicles.

A more detailed explanation of emission factors by source is contained in Section III.

SECTION II

SECTION II: ASSESSMENT PROCEDURES

INTRODUCTION

The purpose of this section is to present the air quality assessment process and discuss some of its major elements. The process is displayed in a series of flow charts which show the relationships of the various assessment tasks. The charts present all the major steps from initial project review to assessment completion and coordination. The flow charts and the associated guidance were developed through discussions with State and local Air Quality Control Agencies, the U.S. Environmental Protection Agency, and FAA and U.S. Air Force personnel.

DETAILED AIR QUALITY ASSESSMENT PROCEDURES

Procedures for environmental assessment must be defined in a general manner for easy understandability by all participants in the process. However, even a generalized presentation is quite difficult to achieve since environmental actions are processed differently in different states. To address this problem, state environmental procedures were reviewed, and certain patterns of procedural similarity were observed. This information has been included in the flow diagram of Exhibit II-1 which incorporates the salient features of the Clean Air Act and the National Environmental Policy Act. The numbered boxes in the flow diagram are referenced in the following discussion. A separate flow chart and discussion of Air Force projects appear later in this section.

The first step in the assessment process is the identification of the proposed project and its basic components (Block 1-1 Exhibit II-1). This review of the project elements should include consideration of their potential effects on the area's air quality.

Certain airport actions or projects will have the potential for air quality impacts, while others will not. Generally, those projects affecting an airport's aircraft operations (type, number, or location) or the related surface traffic may require some level of air quality assessment. An expanded list of projects potentially affecting air quality was developed in Section I to include the following:

- A new airport;

CIVILIAN AIRPORT AIR QUALITY ASSESSMENT PROCEDURES

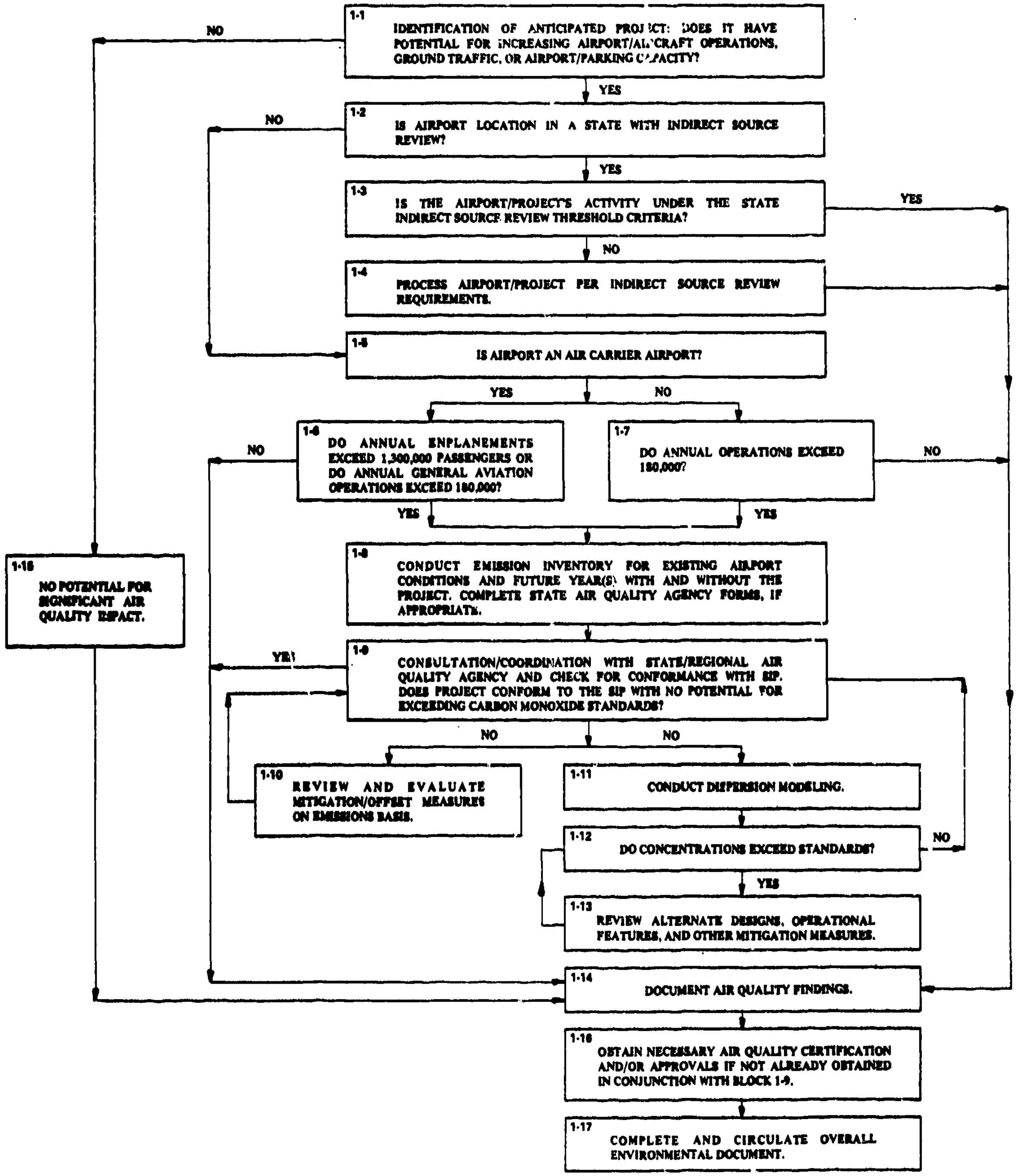


EXHIBIT II-1

- A new runway;
- A runway extension;
- Other physical airside improvements increasing airport capacity;
- Major new construction or expansion of passenger handling or parking facilities; and
- Construction or expansion of an airport power plant.

If the proposed project has the potential to increase operations or traffic, then some air quality assessment may be required (proceed to Block 1-2). If the proposed action does not have the potential for creating a significant air quality impact, it usually will require no further assessment (1-15). However, it is important to note that projects should be evaluated on a case-by-case basis.

If the project does have the potential for increasing operations/traffic and affecting air quality, the next consideration is whether the project is located in a state with Indirect Source Review (ISR) (1-2). If it is not, the procedure then requires direct consideration of the airport's activity level (1-5). If the project is located in a state which has ISR regulations, an investigation should be made of the threshold level which triggers the indirect source review (1-3). This threshold could be expressed in terms of aircraft operations, passengers, or auto traffic. If the project or airport exceeds the state's threshold limits, then the project would have to be evaluated and coordinated according to the applicable ISR requirements (1-4). If the ISR threshold was not exceeded, the project would usually be considered not to have significant effect and the air quality assessment would be completed (1-14).

If the project was not subjected to ISR review, the process would involve a review of the airport's activity. If the airport has relatively low activity, it (or a project there) would be expected to have no significant impact on air quality. On the other hand, a very busy airport with a relatively large number of operations and traffic might have an impact.

In considering the airport's operations, the first step is the general distinction between air carrier and non-air carrier airports (1-5). This distinction is made because subsequent assessment procedures are based on the level of annual enplanements (1-6) for air carrier airports and the number of annual operations (1-7) for other airports. Certain levels of activity are identified as suggested threshold limits above which some detailed air quality assessment is necessary.

For example, non-air carrier airports (1-7), the level at which additional assessment is recommended is 180,000 annual operations. It is estimated that this level of annual activity corresponds to the average hourly general aviation operations which would produce off-site concentrations of CO which would approach 10 percent of the national one-hour standard. Therefore, if annual activity is below 180,000 operations, no further assessment is considered necessary (1-14). If the level is greater than 180,000 operations, an emission inventory will be required (1-8). (A more detailed explanation of how this threshold value was developed is contained in Appendix A.)

For air carrier airports, the criteria for the decision to proceed with further assessment is based on annual enplanements (1-6) as well as the airport's general aviation activity. It is estimated that the level of 1,300,000 annual enplanements is that level which creates 10 percent of the one-hour CO standard when converted to peak hour enplaning passenger automobiles arriving at the curbside. If the level of enplanements is less than 1,300,000 (and the level of general aviation activity is below 180,000 annual operations), no further assessment would be warranted (1-14). If the level of enplanements exceeds 1,300,000 per year (or the level of general aviation operations exceeds 180,000 per year), then additional assessment in the form of an emission inventory is warranted (1-8). (See Appendix A for a detailed discussion of the threshold values.)

The emissions inventory would be conducted (1-8) for existing conditions and future study years, with and without the project. (This inventory process is explained in Section III.) The inventory analysis provides: (1) a first indication of the magnitude of the project's potential impact; and (2) a total pollutant loading which can readily be compared to a published inventory for the project locale (i.e., county, metropolitan area, etc.). The emission inventory would be expressed in pounds or tons per day (or year) generated by each project source.

Contact with the local air quality control board or agency may be required to obtain the comparative inventory data. The agency may also provide state or local forms required for future air quality or general assessment review and document processing (I-8). If it is anticipated that additional assessment will be required, this contact with the air quality agency may facilitate the collection of additional data. The type of data that would be collected and examined at this stage could include: the applicable parts of the State Implementation Plan (SIP); any analysis criteria for various project sources; local air quality regulations; and any ambient air quality data that has been recorded in or near the project site.

Once the emission inventory is completed (1-8), the process would continue with consultation and coordination with the state/regional

air quality agency (1-9) to check for project conformance with the State Implementation Plan (SIP) and discuss any requirements for additional analysis.

The project scope, the results of the emission inventory, state forms, and elements of the SIP would be reviewed along with the action's potential for exceeding carbon monoxide standards. If the project/airport was in conformance with the SIP and it was determined that there was no potential for exceeding the CO standards, the air quality assessment would be completed and documented (1-14).

If after consultation, it is determined that the project or its emissions are not consistent with the SIP on an emissions basis, the project would be reviewed with respect to mitigation or offset measures (1-10) which could be employed to bring the project within conformance.

If a determination is made during consultation that there was the potential for exceeding CO standards, then dispersion modeling would be undertaken (1-11). The need for a microscale analysis to determine air quality impact is unnecessary where the potential of such impacts to exceed NAAQS is judged to be minimum or insignificant. The judgement on the degree of CO impact may be based on: (1) previous analysis for similar projects; (2) previous general analysis for a various class of projects; and/or (3) local conditions.

Whereas the inventory will yield the total amount or weight of emissions (e.g., pounds or kilograms per day or year of operation), the concentrations derived from dispersion modeling are expressed in an amount of pollutant (weight) per unit volume (e.g., grams per cubic meter). These concentrations are generally derived through a pollution modeling exercise. The units are directly comparable with the units of the national standards. The various techniques and methodologies for determining concentrations are explained in the next section of this handbook.

Generally, the carbon monoxide (CO) emissions are the only ones which are modeled since they are generally considered non-reactive and localized in nature. Hydrocarbons (HC) and nitrogen oxides (NO_x) are unstable precursor pollutants which undergo a complex series of reactions resulting in the formation of photochemical oxidants. These reactions, which are more of a regional nature, are not easily analyzed for local airport impacts. Sulfur oxides (SO_x) and particulates are not modeled because they are emitted in such small quantities by the aircraft and motor vehicles.

Once project concentrations are determined for the various study years and conditions, they are compared to the National Ambient Air

Quality Standards (NAAQS) in order to identify areas where violations may occur (1-12). If there are no violations, then consulation is completed (1-9).

If the project concentrations are found to exceed the standards, then further considerations must be given to alternative airport designs or operating procedures which will reduce pollutants to the acceptable levels (1-13). After these alternatives and associated mitigation measures are evaluated, the resulting concentrations are again compared to the standards, and if acceptable, the results of the analysis and mitigation considerations would be summarized and consultation completed.

Once the analyses are completed, all of the findings should be documented for inclusion in the overall environmental document (1-14). Once the air quality documentation is complete, it may be necessary to obtain certification and/or approvals (1-16) from the appropriate agency, if not otherwise obtained during the consultation process (1-9). The air quality documentation would be included in the overall environmental document for circulation and/or review (1-17).

Since Air Force actions are, in effect, Federal actions with a possible environmental impact upon state and local communities in a manner similar to the impact of civil airport Federal actions, many of the procedures outlined in Exhibit II-1 may also apply to Air Force actions. However, to accommodate unique conditions at air bases, a separate flow diagram is presented for Air Force actions.

The Air Force assessment procedures are shown on Exhibit II-2 which presents general assessment steps and the basic air quality assessment procedure. The first consideration in the overall process is the identification of the proposed action and its elements (Block 2-1, Exhibit II-2). Air Force Form 813, "Request for Environmental Impact Analysis," is completed at this stage. On this form, the proposed action and its alternatives and purpose are described, along with the type of analysis required.

Some Air Force actions do not have the potential for creating significant impacts and are categorically excluded from assessment. If the proposed action is categorically excluded (2-1), and there are no other circumstances requiring assessment (2-2), no further analysis is required (2-4). If the action is generally not excluded, or if unique circumstances or policy dictate, further assessment is necessary.

Air Force Form 814, "Preliminary Environmental Survey," is prepared to aid in the development of the assessment (2-3). The form provides the basis for specific impacts (including air quality) to be checked for their appropriate effects. The assessment will proceed based on the expected impacts identified during the survey.

U.S. AIR FORCE AIR QUALITY ASSESSMENT PROCEDURES

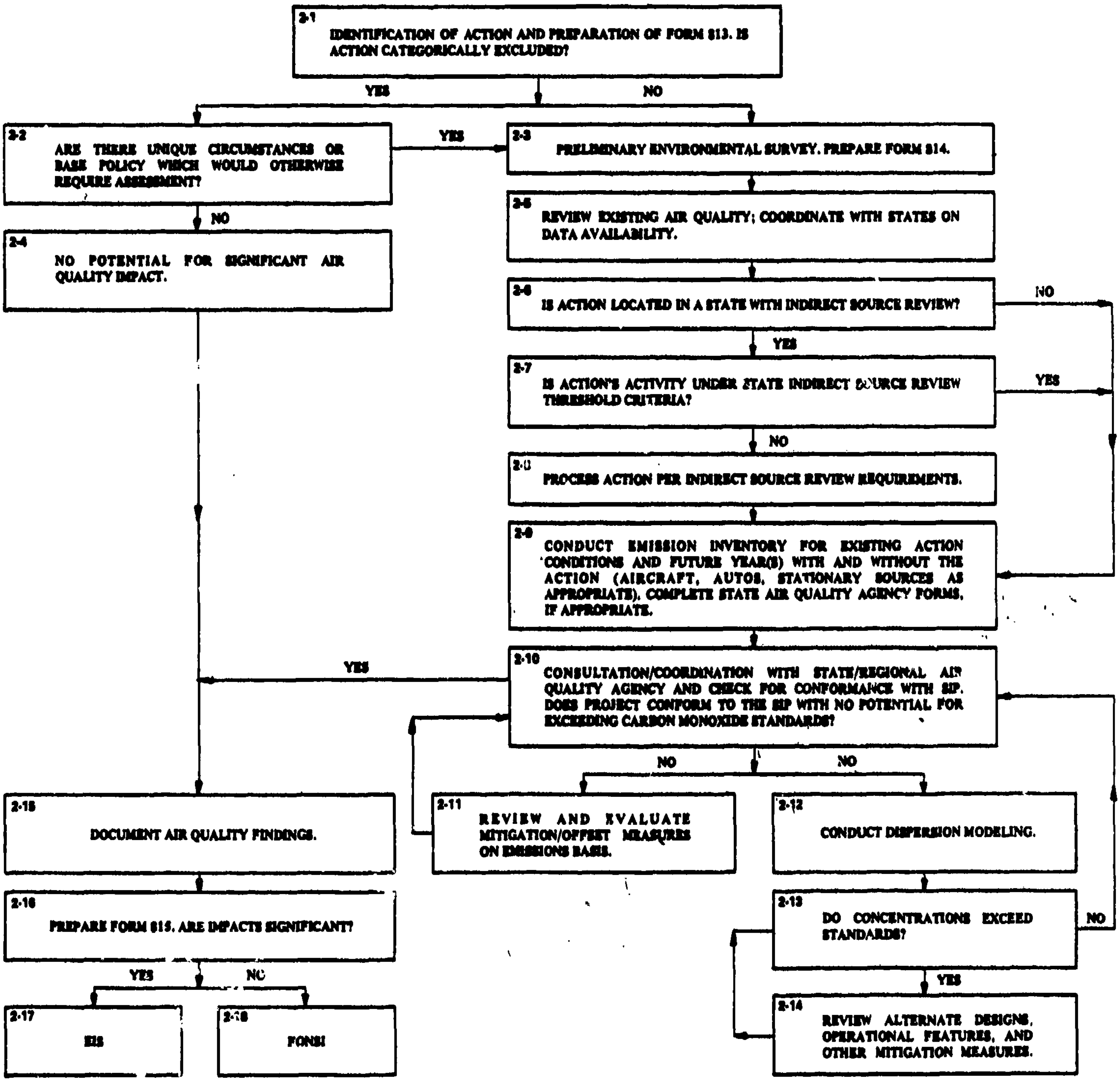


EXHIBIT II-2

If air quality is identified as a relevant impact (2-3), its assessment would begin with a review of available data regarding the existing air quality in the action area (2-5). This may be obtained from previous assessment documents or contact with the appropriate air quality control agency.

Next, a determination is made whether the action is located in a state that has Indirect Source Review (ISR) regulations (2-6). If the state has no such review, the assessment proceeds with the development of an emission inventory (2-9). If the action is in a state with ISR and the action's activity level exceeds the associated threshold criteria, then the action must be analyzed and coordinated according to the ISR requirements (2-7 and 2-8). If under the threshold, the assessment proceeds to the emission inventory phase (2-9).

An emission inventory would be prepared both with and without the proposed action (2-9). This would generally involve the determination of the daily or annual emissions of the military aircraft operating as a result of the action. For large scale actions, the inventory could include emissions from related base traffic or existing heating plants.

One of the most useful tools in developing the aircraft emission inventory is the U.S. Air Force Report entitled "Aircraft Air Pollution Emission Estimation Techniques-ACEE"[1]. This report presents a methodology for use by base level environmental personnel to calculate annual aircraft emissions and downfield pollutant concentrations. Individual engine emission factors and other data is contained in the report. The U.S. Air Force Occupational Environmental Health Laboratory (OEHL) acts as the Air Force consulting branch for questions involving Air Force air pollution emission inventories.

Upon completion of the emission inventory, consultation/coordination with the state/regional air quality agency (2-10) would occur to determine the action's conformance with the State Implementation Plan (SIP) and/or if it had the potential to cause carbon monoxide (CO) standard violations. If it is determined that the action is not consistent with the SIP, then mitigation or offset measures would be investigated (2-11). If there is no or very little potential for exceeding CO standards, then the analysis is completed and the results can be summarized and documented (2-15).

If there is the potential for CO standard violations, then dispersion modeling should be performed (2-12). CO concentrations would be

---

[1] Report No. CEEDO-TR-78-33, September 1978, Det 1 (AFESC/ECA, Tyndall AFB, Florida 32403.

calculated and compared to CO NAAQS to locate areas where violations may occur (2-13). If there are no violations, then the analysis is completed and the results can be summarized (2-15).

If CO standard violations are found, then further considerations must be given to operating procedures or alternative designs which would reduce pollutants to acceptable levels (2-14). After these alternatives and associated mitigation measures are evaluated, the resulting concentrations are again compared to the standards, and if acceptable, the results of the analysis and mitigation considerations would be summarized (2-15).

If dispersion analysis is warranted, several methods of investigation are available, depending on the type of action. For example, for a unit conversion, downwind concentrations can be estimated using the "ACEE Report" or the U.S. EPA's PAL model. For low level actions, concentrations can be estimated with the PAL model, or, in more simplified cases, with the Simplex 'A' models (see Section III). For the establishment of a new air base, the Air Force AQAM model (Air Quality Assessment Model) may be used. The AQAM is a Gaussian plume dispersion model designed for Air Force aircraft operations. It predicts hourly and annual downwind pollutant concentrations based on operational profiles and appropriate engine emission rates. Most assessments performed by the Air Force would not require the use of AQAM; its use would be limited to the larger scale actions or specific research and development efforts.

Upon completion of all the air quality analysis, the results would be summarized and documented (2-15) for inclusion in the overall assessment report.

Once all the impact analyses have been completed, the results are to be evaluated for significance (2-16). If the impacts are significant, an Environmental Impact Statement (EIS) would be required (2-17). If the impacts were found not to be significant, the Finding of No Significant Impact (FONSI) would be the appropriate document choice (2-18). Air Force Form 815, "Environmental Assessment Certificate," would be completed and would contain a recommendation as to the document choice required.

STATE IMPLEMENTATION PLANS

One of the major tools used in the air quality assessment process is the State Implementation Plan (SIP). This tool has its origins in the Clean Air Act, which required each state to develop and adopt such a plan (Section 110).

The purpose of the plan is to provide for the implementation, maintenance, and enforcement of the National Ambient Air Quality Standards for each Air Quality Control Region within each state. The implementation plan is the primary vehicle used by the EPA for the enforcement of Federal air pollution legislation.

The principal parts of an implementation plan include:

- emission limitations, schedules, and timetables for attainment of the primary and secondary standards, including but not limited to transportation controls, air quality maintenance plans, and preconstruction review of direct sources;
- provisions for establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, compile and analyze data on ambient air quality;
- a program to provide for the enforcement of emission limitations and regulation of the modification, construction, and operation of any stationary source;
- adequate provisions prohibiting any stationary source from emitting any air pollution in amounts that will prevent attainment of any ambient air quality standards;
- provisions that no major stationary source shall be constructed or modified in any nonattainment area if the emissions from such facility will contribute to concentrations of any pollutant for which a NAAQS is exceeded in such area; and
- provision for the incorporation of regulations for Prevention of Significant Deterioration (PSD).

Thus the State Implementation Plan is a collection of regulations and procedures, strategies and data, policies and technical memos: it may offer guidance for the modeling of stationary source emissions; it may list policies to be followed for nonattainment and PSD areas; or it may describe the scope of a Transportation Control Plan (TCP). It is likely that all of this information would not be found in one document, but in several related sources.

Section 176(c) of the Clean Air Act Amendments of 1977 provides the basis for the relationship between the SIP and Federal projects when it essentially states that no Federal agency shall support or approve any activity or action which does not conform to an SIP after it has been approved or promulgated under Section 110 (of the Act). Assessment of Federal projects, then, must include documentation and discussion of the action's consistency with the SIP.

The development of a consistency determination is based upon an evaluation/comparison of the airport project's impacts, sources, emissions, pollutant concentrations, and mitigation measures with the appropriate element or component of the implementation plan. For example, the evaluation/comparison may involve: pollutant concentrations and national/state standards; emissions and offset procedures; emissions and pollutant increments; or mobile source emissions and transportation control plan strategies.

AGENCIES IN THE ASSESSMENT PROCESS

It should be clear from previous sections that several different agencies become involved in the air quality assessment process. These agencies are found at the Federal, State and local levels of government, and include:

- The U.S. Environmental Protection Agency (EPA);
- The Federal Aviation Administration (FAA)/ Federal Highway Administration (FHWA)/U.S. Air Force;
- State and/or local Air Quality Review Agency/ Board;
- Regional or local planning departments; and
- The local airport sponsor.

On the Federal level, the Environmental Protection Agency (EPA) is charged by Congress to protect the nation's land, air and water resources. Under a mandate of national environmental laws focused on air and water quality, solid waste management and the control of toxic substances, noise and radiation, the Agency strives to formulate and implement actions which lead to a compatible balance between human activities and the ability of natural systems to support and nurture life.

To achieve the air quality goals, the EPA has issued the National Ambient Air Quality Standards (NAAQS) which limit various pollutant levels. The EPA also issues guidelines and regulations that are to be adhered to in order to maintain these standards. For areas that are currently exceeding NAAQS, the EPA has published a timetable and schedule to be followed for these areas to reduce their pollutant levels. The EPA would seldom get involved in early project review with an airport owner, but could become a "cooperating agency" to the FAA during the EIS process. As a cooperating agency, EPA would be responsible for developing certain information for portions of the Environmental Impact Statement.

The FAA, FHWA and similar agencies have taken the provisions of the Federal legislation and incorporated them into their own assessment procedure documents. These agency documents provide guidance and analysis procedures for the disciplines to be studied. In the early assessment tasks, the FAA would have the responsibility to comment on the scope, type, and procedures for the technical air quality investigations in order

to insure consistency with the Administration's environmental guidance and related legislation. The FAA could also identify available resource material to be used in the assessment. If parts of the air quality assessment are subsequently used in a formal FAA environmental document, then the FAA must take responsibility for its content and results.

The FHWA would become involved where major access road improvements are part of the project to satisfy Federal EIS coordination regulations. The FHWA could provide guidance on automotive emissions and on the use of highway air quality modeling techniques.

The U.S. Air Force, through its base level and command level staff, would become directly involved if proposed military actions have the potential for air quality impacts. Base level and command level personnel would be involved in the actual analysis, State/EPA coordination, and document review. The Air Force OEHL would act as the consulting branch on aircraft engine emissions.

The State Air Quality Control Board has a primary review responsibility. They must also insure that all Federal and State guidelines are observed. The State regulations may be more restrictive than the Federal ones. This agency may also assist in evaluating the analysis procedures and the degree of involvement that must be enjoined to obtain an acceptable air quality assessment. The State Board will also be able to supply historical records of the quality of the ambient air and help establish what background air quality data should be used for the project location.

There may also be local Air Quality Control Boards that would become involved in the airport action. They do not generally set policy guidelines, leaving that to the State Air Quality Agency, but they would have review responsibilities. Consultation with these boards is necessary in order to obtain their approval of the project. Consultation with the appropriate agency is identified in the overall Assessment Flow Chart. The State and local air quality agencies are the sources of background data and SIP components.

There may be other environmental-related agencies that would become involved in an airport action. The State and local planning boards would be able to comment on the existing land use around the airport and may also provide air quality data on regional emissions.

The local airport sponsor (or consultant) has the responsibility for developing the initial scope of the air quality assessment, consistent with Federal and local requirements and other related impact disciplines. The sponsor or owner would be able to provide the necessary operational data for the various study years along with physical data regarding the airport layout and future plans.

Thus, the air quality assessment for airport actions involves coordination and input among agencies at many levels and at several important points in the process.

STATE ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Since coordination with the states on air quality issues is important and appropriate, an investigation was made of the state's general environmental procedures and their specific air quality assessment/processing requirements in order to help define the type and extent of the coordination. This section summarizes the results of that investigation.

About one-half of the states have their entire implementation plan approved, the remainder have partial or conditional approval. This latter category includes those of which the EPA has accepted certain parts, while calling for revisions of the rejected portions. Most of the sections to be revised deal with nonattainment areas and strategies for these areas to meet and maintain the National Ambient Air Quality Standards as mandated by the Clean Air Act amendments. The affected states are in the process of revising their SIP, or have revised it and are waiting for EPA approval.

Several of the states have Indirect Source Review (ISR) regulations. In a few states these regulations only apply to small localized areas. The states that do have indirect source review have established threshold levels above which the review is necessary. These thresholds are based on either parking lot capacity, highway annual daily or hourly traffic volume, airport passengers per year or volume of airport operations. Airports with operations or volumes below the threshold level would be exempt from the review. These threshold numbers vary among the states; each would have to be checked individually to determine if ISR is required.

In addition to each state's SIP, most states have their own Environmental Regulations that determine overall assessment procedures. These regulations are usually similar to NEPA, yet differing in that projects of statewide significance are the focus of studies to determine impact. These regulations contain guidelines for document processing and methodologies to be used for analysis. If it is necessary to obtain permits to operate or construct the proposed facility, the instructions and types of permit would be included within the State Environmental Regulations.

Few states have any formal type of procedures for early project consultation to discuss a project's potential air quality (or other) impact. Some states have environmental project review forms that have to be completed and submitted. These forms, which contain general information about the project and its expected emissions, are usually used by the agency to perform their own analysis for determination of SIP consistency. These forms generally apply to stationary sources rather than mobile sources.

The state agencies investigated stated that they would welcome the opportunity to meet with the project managers/officers and outline potential project impacts; this meeting would have to be initiated by the agency/sponsor/air base conducting the assessment.

The states use a combination of factors to determine conformance with the SIP. The most common are: (1) the project's emission totals; (2) the air quality impact or concentration generated by the project; (3) and the allowable PSD incremental growth. The states would check to determine if the project would delay or impede the attainment of air quality standards and if the project would contribute to the exceedance of the standards. In PSD areas, the project would also be examined to determine its consumption of the PSD increment.

Most states identify aircraft emissions separately in their emission inventories. A few states even distinguish between commercial and military aircraft emissions, but this is a rarity. The states that identify aircraft emissions also account for future aircraft emissions in their incremental growth totals listed in the SIP. The remaining states include aircraft emissions in their summaries of areas sources or as miscellaneous sources. These states generally do not have the means to distinguish and separate aircraft emission due to the low level of aircraft operations.

Most states require dispersion modeling when the project has the potential to exceed ambient air quality standards or create additional carbon monoxide (CO) hot spots. When the project is in a nonattainment area, CO modeling is also usually required. Those states that have Indirect Source Review requirements would require CO modeling for all projects subject to indirect source rules. A few states require CO modeling when: (1) the project is not accountable in the SIP, or (2) the project is planned for years beyond SIP-modeled years, or (3) if transportation assumptions used are different from those used in the SIP.

Each proposed project has to be evaluated on its individual basis, depending on the type of project and the state involved. Some states have stricter regulations than others. The best guidance to follow is to provide the opportunity for consultation with the appropriate air quality agencies early in the assessment process.

UNIQUE/SPECIAL AIRPORT PROJECTS

Frequently, the analysis of airport actions is complicated by the location of the project or the number/type/layout of sources within the project. When an airport action is near a large metropolitan area, it will frequently be in conflict with surrounding land uses, influencing the project layout and operation.

Another problem that can arise in a large airport action is the diversity and complexity of sources. The most commonly occurring problems arising from larger airport actions include:

- numerous runways and taxiways with frequent crossings;
- parking lots or garages located near the terminal area, contributing to terminal curb side congestion;
- complex roadway system which would involve controlling access and regulating flow of traffic;
- terminal curb side located in areas where airflow is restricted with congestion developing from stopped vehicles;
- heating or power plants that may require fuel storage areas (coal yards); and
- fuel farms where there can be a large build-up of HC emissions from frequent fuel handling;

These unique problem areas may be present singularly, but in a large airport, more than one can be expected to be encountered. Each source type in an area of conflict would require a different analysis procedure. Each source or point of conflict should be analyzed and dispersed separately. The total pollutant impact at any receptor point would be the result of adding the contribution from each source to that selected point. Where there are relatively large contributions of HC from fuel facilities, or where a tunnel effect is created at curb side, the assessment process and documentation may include monitoring of ambient conditions.

MITIGATION OF AIRPORT POLLUTION

One of the major considerations in any impact investigation is the ability to mitigate, if not eliminate, the adverse impacts of project development or implementation. Mitigation for potential airport air quality impacts would be directed at reducing the overall emission inventory and the pollutant concentrations at selected receptor points.

Abatement strategies to mitigate air pollutant impacts can be used during both the construction phase and the operational phase of an airport project. During the construction phase, measures can be employed to control or restrict open burning of spoil materials, to reduce sediment runoff by exposing a minimum area of land, and using water or stabilizing agents to control dust and particulate emissions.

The abatement strategies implemented during the construction phase are fairly straightforward and principally a matter of enforcement. The operational phase of an airport project, on the other hand requires a larger set of more complicated abatement strategies. Each of the source types has a number of abatement strategies associated with it.

The primary source, aircraft engine exhaust emissions, can best be controlled by engine modifications and redesign, methods that can not be controlled by airport planners. The only procedures that can be utilized during airport operations are modifications of ground operations. These procedures would include increasing idle speed, use of minimal number of engines for taxiing, reducing the length of taxiing, and minimizing the time waiting to park at a terminal and shorten queuing at departure runways. The types of measures may require planning revisions to the airport layout.

The second major source of pollutants at airports is the automotive engine exhaust, especially when each is idling or moving at a low rate of speed. High levels of vehicular pollutants occur at the terminal curb side. Planning efforts can be made to reduce congestion in such areas. The service roadways should be designed to restrict the number of signal controlled intersections and to maintain constant travel speeds on such facilities. Parking areas should be located and designed to reduce congestion at the terminal facility. There should also be sufficient gates in each parking area to minimize departure waiting times. Various forms of mass transit could also be offered as an alternative method to arrive and depart from the airport.

The aircraft ground service vehicles could also be controlled to reduce pollutant levels. Currently these vehicles are classified as off-the-road vehicles not subject to emission controls. The easiest method would be to use only vehicles that are electric or propelled by propane gas.

Emissions from maintenance facilities and heating plants can be controlled by installing various control equipment on smoke stacks or other emission outlets. Heating and air condition plant emissions are also dependent on the fuel being used, buildings being serviced and the condition of equipment being used. Equipment that operates efficiently will normally emit fewer pollutants.

The last major source of pollutants from airport activity is from the fuel farms. A fuel-handling and fuel-storage system will generate a significant quantity of HC. The leakage can be most readily controlled through the installation of a vapor recovery system. Emissions can also be controlled by reducing the number of times the fuel must be handled. A closed system from the fuel tank farm to outlets located near aircraft parking areas would be the most efficient method to employ.

Bubble Policy

One abatement strategy that can be applied to the entire airport/ air base facility is an application of the EPA Bubble Policy. Under the Bubble Policy, all the emission points at a facility are treated as being under a giant bubble with only one release point to the atmosphere. The bubble can be applied to both a single source or a combination of sources located in close proximity to one another. This allows a relaxation or elimination of pollutant controls at a source where costs are high in exchange for compensating increased controls on sources where costs are low.

This policy would give the airport/air base operator greater flexibility to meet current or future air pollution control requirements, makes new control approaches profitable and can save the airport/air base operator millions of dollars annually over the cost of conventional controls.

Bubbles are not usually applied to civil air carrier airports where most sources are mobile. On the other hand, a bubble could be applied to an air base which usually contains both mobile and point sources.

SECTION III

SECTION III: ASSESSMENT METHODS AND MODELS

INTRODUCTION

The previous section has outlined and highlighted the various steps in the overall air quality assessment process. This section focuses on the available techniques and methodologies to be used if it is determined that the particular proposed action indeed requires assessment.

The assessment of air quality involves two activities: (1) the development of an emission inventory, and (2) the calculation of the dispersion of these emissions to produce a concentration. The distinction between the two was mentioned in the previous section of this handbook: the inventory is the total amount or weight (pounds or kilograms) of pollutants generated during a specified time period (i.e., day, year); whereas, the concentration is an expression of an amount (weight) of pollutant per a unit volume of air for a given averaging period. When a detailed assessment is required, both indices of air quality impact may need to be investigated. This section outlines the procedures for conducting an emission inventory and discusses the range of techniques for determining pollutant concentrations.

SOURCE AND USE OF EMISSION FACTORS

A key element in the assessment of air quality impact is the emission factor for each identifiable source within the proposed project or action. An "emission factor" is the rate at which the pollutants of a source are emitted, usually expressed in terms of pounds (kgs) per unit of time of operation. The emission factors and their sources will be discussed in terms of each major airport source.

Aircraft

Each type of aircraft in the project's fleet mix has a particular engine type with its own particular emission rate. For example, a Boeing 707 aircraft has JT3D-7 engines, a Boeing 727 uses JT8D-17 while a Boeing 747 could have one of three types (JT9D-7, JT9D-70 or RB211-524). Table 3.2.1-1 in AP-42[1], lists aircraft types and their most commonly used engines. The Air Force ACEE Report has detailed information on military aircraft.

---

[1] See Reference 14 in the Annotated Reference List in Section V.

Two types of data are available for each engine type: modal emission factors (pounds pollutant per hour at each operating mode); and emission factors per aircraft landing-takeoff (LTO) cycle (total pounds pollutant per LTO).

Engine emission data is based on the aircraft's landing and takeoff cycle. A landing-takeoff cycle includes all normal operational modes performed by an aircraft between the time it descends through an altitude of 3,000 feet (910 meters) on its approach, and the time it reaches the 3,000-foot (910 meters) altitude after takeoff. Each class of aircraft has its own typical LTO cycle, separated into five distinct modes: (1) approach and landing; (2) taxi-idle in; (3) taxi-idle out; (4) takeoff, and (5) climbout. Operating times at a congested airport for each mode of the cycle as well as both types of emission factors are listed in AP-42. When aircraft do not operate in a congested airport or where other unique conditions exist, the preparation of a special LTO for the project may be appropriate.

If a particular aircraft mode is not listed in the referenced tables, this does not mean the emission factors cannot be calculated. The engine emissions or emission index as well as the fuel flow rate can be obtained from the manufacturer and the modal emission rate can be calculated.

As an example, carbon monoxide emission rate for the Pratt and Whitney JT9D-7 gas turbine engine would be determined as follows:

Mode: idle

Fuel Flow: 1,849 lbs/hr

Emission Index: CO - 77 lbs/1,000 lbs fuel (idle mode)

Emission Index x Fuel Flow = Modal Emission Rate

$$77 \frac{\text{lb CO}}{\text{1,000 lbs fuel}} \times 1{,}849 \frac{\text{lbs fuel}}{\text{hr}} = 142.37 \frac{\text{lbs CO}}{\text{hr}} \text{ per engine}$$

This rate applies to each hour of operation in the idle mode. Similar procedures are used for the other modes and pollutants.

Automobiles

Automobile engines, unlike aircraft engines, are classified by type (light duty, heavy duty, etc.) and not by manufacturer. Many variables affect the computation of the emission factors. These include:

- Operating Mode

  The four general operation modes are idle, acceleration, constant speed (cruising), and deceleration.

- Vehicle Mix

  Highway vehicles are divided into two categories, light duty and heavy duty vehicles. Within each category, power plant and fuel variation result in significantly different emission characteristics. The resulting subcategories are: light duty gasoline powered vehicles; light duty diesel powered; light duty gasoline powered trucks; heavy duty gasoline powered vehicles; heavy duty diesel powered vehicles; and motorcycles.

- Application of Control Devices

  Starting in 1968, light duty vehicles contained exhaust emission controls. These exhaust emission controls deteriorate with time, thus causing higher emissions over time.

- Vehicle Age Distribution

  The aging of highway vehicles causes deterioration in vehicle engines, vehicle exhaust systems and catalytic devices, creating higher rates of exhaust emissions.

- Operating Speeds

  Emission rates of highway vehicles are directly related to vehicle speed. As operating speeds increase, emissions of CO and HC decrease, while those for NO_x increase. Changes in speed also

contribute to higher emissions, since emissions of HC and NO_x in the acceleration mode are significantly higher than those at a constant speed.

Using these parameters, emission factors can be calculated for autos with the methodologies and formulas contained in AP-42 or through the utilization of the computer model, MOBILE II. The emission factor obtained by either method will be an average emission factor in grams per vehicle mile for a characteristic vehicle mix for a particular calendar year. These emission factors are available in tabular form from the Federal Highway Administration[2] and can be used for simple scenarios.

Service Vehicles

Emissions from airport service vehicles, like automotive emissions, are dependent on vehicle age distribution, average vehicle speed, and mode of operation. Normal activities encountered by service vehicles involve average operating speeds and variable running times. Their emissions are thus related to vehicle fuel consumption. The emission factors are expressed in units of pounds of pollutant per gallon of fuel consumed (gas or diesel).

Service vehicles are currently classified as off-road vehicles and not subject to emission controls. For each pollutant, only one emission factor has been developed for all gasoline powered service vehicles, and one for all diesel powered vehicles. The methodologies used in computing these emission factors along with the emission factors are contained in EPA Report APTD-1470.[3]

Stationary Sources

The emission factors for stationary or point sources are determined by the process to be analyzed, equipment to be used and the type of fuel burned. The type of fuel to be used will usually exert the greatest influence on the type and quantities of pollutants that will be emitted. AP-42 lists emission factors for most types of stationary sources.

---

[2] Mobile Source Emission Factor Tables, FHWA, Washington, D.C. Technical Advisory T6640.1, November 16, 1978.

[3] See Reference 11 in the Annotated Reference List in Section V.

EMISSION INVENTORY

Purpose and Uses

The inventory of emissions yields the total amount of pollutants emitted by the project in a day's or year's operation and gives an indication of the magnitude of its potential impact. The flow chart identified when the inventory would be determined in the assessment process.

Though the units of the emission inventory (pounds) are not directly comparable to the national standards, the emission inventory can be used in several ways in the overall assessment of the project. The first way in which the inventory can be used is in the comparision of alternatives. Alternative layouts or procedures may produce varying emission totals. Minimization of total air quality emissions may be a factor in the selection of a preferred alternative.

The second manner in which the inventory can be used is in the comparison of existing totals with future totals, both with and without the project. This will provide a direct identification of the impact of the proposed action. This comparison may reflect tradeoffs between the expected increase in airport operations and traffic, and the decrease in future emission rates.

The third way in which the inventory can be used is in the comparison with published inventory data for the county or region. Most published air quality data is in the form of an inventory for various sources in the political/planning area. The comparison will disclose the actual relationship between the project's emissions and all other major sources in the area.

Data Requirements and Methodology

To begin the inventory, the various sources associated with the action should be identified. All potential sources will be categorized as either stationary sources or mobile sources. The type of source will dictate which methodology and procedures will be required to evaluate its potential emissions.

For aircraft sources, data is required regarding the daily number of LTO cycles for each type of aircraft, the modal emission factors, and time spent in each mode. The modal emission factors can be obtained from

AP-42 or the Air Force "ACEE Report" as discussed previously. Using the modal emission factors and the times in mode, a pollutant loading factor can be obtained for each aircraft:

> Pollutant loading factor (per pollutant) = [Idle Modal Emission Factor (lb/hr - engine - LTO) x Time in Mode (hr)] + [Takeoff Modal Emission Factor x Time in Mode] + [Climbout Modal Emission Factor x Time in Mode] + [Approach Modal Emission Factor x Time in Mode].

The times for each mode should reflect the actual operating conditions at the airport. Typical modal times for larger metropolitan airports are listed in AP-42 for civilian aircraft and can be used as a guideline for selecting actual times to be used. For military aircraft, the U.S. Air Force publication, "Aircraft Pollution Emission Factors and Landing and Takeoff Cycles" (AFWL-TR-74-303) can be used. For example, the pollutant loading for a jet using the JT9D-7 engine would be:

$$[142.4 \text{ lb/hr - engine - LTO} \times \frac{19 \text{ minutes}}{60 \text{ min/hr}}] +$$

$$[3.23 \times \frac{.7}{60}] + [6.6 \times \frac{1.8}{60}] + [44.62 \times \frac{3.8}{60}] =$$

48 lb/engine - LTO

This pollutant loading factor is then multiplied times: (1) the number of LTO's per day; (2) the number of engines for that aircraft to obtain the total emissions for the day for that pollutant for each aircraft. For the same example, the daily emission total would be:

> Emissions = [48.15 lb/LTO - engine] x [2 LTO/day] x [4 engines] = 385 pounds per day of CO for the subject jet

The daily emissions would then be summed for all aircraft types for each pollutant and for each study year.

For automobiles, data should be obtained for vehicle mix, average travel speed, length of average trip or length of roadway links in the access system, and the volume of vehicles (the average daily traffic for

each study year). As discussed previously, the auto emission factors can be computed by using the MOBILE II computer program or by hand calculations using data provided in AP-42.

The pollutant emission factor for a desired speed and the designated study year would be multiplied times the average trip length or roadway link times the volume of daily traffic on that link. A typical calculation would be:

Given:

CO Emission Factor for 1980, speed 55 mph - 31.61 gm/mi

Daily Average Traffic - 3,176 vehicles

Length - 1 mile

Emissions = 31.61 gm/mi x 3,176 vehicles x 1 mile =

100,393 gm/day ÷ 453.592 gm/lb = 221 pounds per day

of CO Emissions on a link of the access system.

The daily emissions would then be summed for all links for each pollutant and for each study year.

Another source of emissions at airports are the vehicles that service the aircraft. The number and type of service vehicles is determined by the types of aircraft which use the airport. Once each particular aircraft volume is determined then this volume is multiplied times the service time for each vehicle that is required then times the fuel consumption rate and then times the vehicle emission rate. An example of this type of calculation is:

Given:

Tractor Time for Service of a 747 = 155 veh-min

One 747 per day

Fuel Consumption Rate = 1.80 gal/hr

Operation Time = 1 x 155 veh-min x $\frac{1 \text{ hr}}{60 \text{ min}}$ = 2.58 veh-hr/day

Fuel Consumption = 1.8 gal/hr x 2.58 veh-hr/day =

4.64 veh-gal/day

CO Emission Rate = 2.20 lb/gal

Daily CO Emissions = 4.64 veh-gal/day x 2.20 lb/gal =

10.22 lb/day.

Typical stationary sources located at airports include fossil fuel burning smoke stacks and fuel farms. For stack analysis, the operating features that are associated with the source must be known. The operating features would include the type of fuel being used, the chemical composition of that fuel, the rate at which the fuel is being burned, temperature of escaping gases, and the average ambient temperature. If detailed data is not available, then the emission rates listed in AP-42 should be used to approximate the stack emissions. While the physical characteristics of the stack (height, size) are not needed to determine the total emissions, consideration must be given to any emission control devices that are to be used (scrubbers, bag houses).

The emission inventory for each stack would be computed by multiplying the derived emission rate for each pollutant per stack process times the amount of fuel consumed times the number of hours of operation during the day. A typical calculation would be:

$$\text{Daily Emissions} = 20 \text{ lb of } SO_2 \times 5 \text{ ton/hr} \times \frac{10 \text{ hr}}{\text{day}} =$$

1,000 lb/day of SO_2 emitted

Fuel farms, while classified as stationary sources, are analyzed differently. To determine emissions from fuel tanks, data must be obtained regarding type of containers or tanks to be used, the type of fuel, the amount of fuel to be handled per day, and the sequence of fuel handling.

Emissions from fuel farms are primarily generated each time the fuel is handled. The emissions are composed predominately of hydrocarbons (HC), which contribute to ozone formation. The HC emission rate is determined by the particular brand of fuel. To obtain the daily emissions, the emission rate is multiplied times the number of gallons to be consumed or handled. An example calculation is:

Given:

Emission rate for jet fuel = 0.55 lbs/10^3 gal of fuel

Usage rate - 600,000 gal/day

Daily Emissions = 0.55 lbs/10^3 gal x 600,000 gal/day = 330 lb/day of HC

While the sources previously discussed are the major emission source classifications, other types of sources may be involved due to the uniqueness of the proposed airport project. These types of special sources may be included in AP-42 with generalized emission rates. If the sources are not discussed in AP-42 then coordination with the EPA or State Air Quality Review Board may be necessary to obtain their potential emissions.

The results of each of these computations will be an emission loading in pounds per day (or year) per pollutant for each type of source. These numbers can then be summed to find the total loading for the facility.

MODELING TECHNIQUES

The second aspect of a detailed air quality assessment involves emission concentrations. The basic purpose for conducting the concentration analysis is to assess the project's impact in terms of the National Ambient Air Quality Standards (NAAQS). This section provides a discussion of the various techniques and methodologies for computing these concentrations.

All of the techniques require the same general data requirements, however, the more complex models require more detailed information than the simpler techniques. Basically, data requirements include: airport landside/airside layout features; operational data - number and type of aircraft and related surface vehicles; emission factors for all identifiable sources; and general meteorological data, such as average wind speed and direction.

Modeling is generally performed to evaluate carbon monoxide (CO) emissions only. As stated previously, the CO emissions are localized short-term pollutants which lend themselves to this type of evaluation.

Numerous models, using different mathematical approaches, have been developed for handling the various conditions and sources which may be encountered in the air quality studies for airport projects. The most commonly used models are listed in Table III-1.

Some of these models have been classified by the EPA as Guideline Models, i.e., one that when used properly produces results that are acceptable to the EPA without a detailed explanation of model parameters. EPA accepts as guideline models only those models that have fulfilled a number of verification and documentation tests.

Some models may be part of a UNAMAP series. UNAMAP (which stands for User's Network for Applied Models of Air Pollution) is a library of air quality simulation models compiled by the EPA and available through the National Technical Information Service (NTIS).

This discussion will highlight the major points of each model; more detailed information is provided in the respective references listed in Section V. All of these models are principally microscale dispersion models that are best suited for assessing air pollution impacts on a localized scale, since they focus on areas in the immediate vicinity of the project under study.

Table III-1

Summary of Commonly Used Models

Accelerating Airplane	Complex Source[c]	Line Source	Area Source	Point Source
Simplex 'A'[f]	PAL[b,d]	HIWAY[a,b,d]		PTMAX[a,b,d]
	AVAP[d]	CALINE[a,d]		PTDIS[a,b,d]
	AQAM[e]			PTMTP[a,b,d]
	GIMM[g]			CDM[a,b,d]

---

a Guideline Model.

b UNAMAP Model.

c Algorithms from PAL, AVAP or AQAM can be used to analyze less detailed projects involving Point, Line, Area or Accelerating Airplane Sources.

d Available from NTIS.

e Available from the U.S. Air Force, AFESC/RDV, Tyndall Air Force Base, Florida.

f Available from FAA-AEE, 800 Independence Avenue, S.W., Washington, D.C.

g Graphical Input Microcomputer Model (GIMM) under development jointly by the U.S. Air Force and the FAA.

A dispersion model may be defined as a mathematic structure which:

- Accepts data on source emissions, meteorological conditions, geographic boundaries, etc. as inputs;
- Computes the dispersion of pollutants by the atmosphere; and
- Produces output data on the concentration of pollutants over the area of interest for specified time periods.

Thus, the dispersion model is a mechanism for translating emission data into ambient concentration estimates.

Dispersion models can be divided into two categories: models for non-reactive, inert pollutants such as CO and TSP, and models for reactive pollutants such as NO_x and O_3. There are a wide variety of models available to analyze non-reactive pollutants. These models, once given meteorological conditions and emission rates as inputs, compute primary pollutant concentrations for the averaging time(s) of interest, i.e., one-hour to annual averages.

Modeling of reactive pollutants is much more difficult. The basic problem in studying these pollutants is that they form secondary pollutants whose prediction is very difficult due to the complex nature of photochemical reactions.

Mathematical models used in estimating future pollution levels resulting from aircraft or airport actions require meteorological parameters as inputs. These include parameters such as wind speed and direction, atmospheric stability, and mixing heights. These meteorological parameters are used to find the direction of pollutant transport, the receptors which will be affected, and the most probable and worst pollutant concentrations which can be expected at these receptors.

Microscale modeling determines the pollutant levels adjacent to the particular project. Meteorological inputs needed for the dispersion models require worst and average dispersion conditions for short duration and long duration model studies. Meteorological inputs required for microscale modeling include:

- Most probable and worst case stability classes;
- Predominant wind direction obtained from wind roses; and
- Average wind speed.

Aircraft sources can be modeled using either accelerating aircraft models, such as Simplex 'A,' or the more complex source models such as PAL, AVAP, and AQAM.

Simplex 'A'[4] (Accelerating Aircraft Sources)

The FAA is developing a series of user-friendly atmospheric dispersion screening models to facilitate air quality assessments by field personnel.

The first model, Simplex 'A,' for which a user's guide is available, calculates concentrations from departing aircraft and has been programmed for the Hewlett Packard 67 and 97 desk calculators.

Simplex 'A' is an integrating puff model for an accelerating point source. Downwind receptors are assumed to be at ground level and receive concentration doses from each emission puff. The dose from each emission puff is summed to give the total dose due to a complete takeoff event. During engine operation an exhaust tail is created behind the engine. While the geometry and emission rate variation along this tail have not as yet been quantified, preliminary measurements and observations have permitted the selection of values for the length and number of emission release points in the emission tail. While the sensitivity of pollutant concentration to the length and number of assumed release points in the tail varies with the location of the receptor, a tail length of 225 meters with three equally spaced emission release points was found to reflect nominal values that were relatively insensitive to moderate changes in these parameters. The following equation is used in the puff iteration process.

[4] See Reference 22 in the Annotated Reference List in Section V.

$$X = \frac{Q_T}{\pi \sigma_{z_T} \sigma_{y_T} U} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_{z_T}}\right)^2\right] \exp\left[-\frac{1}{2}\left(\frac{Y}{\sigma_{y_T}}\right)^2\right]$$

where

Symbol		Definition	Units
x	=	Receptor exposure or dose	ppm-sec
Y	=	Crosswind distance	meters (m)
σ_{z_T}	=	Standard deviation of plume concentration in the vertical direction	m
σ_{y_T}	=	Standard deviation of plume concentration in the crosswind direction	m
U	=	Wind speed	meters/sec
Q_T	=	Total emissions during an emission release	grams
H	=	Effective height of emissions	m

The resultant pollutant concentration (x) is expressed in units of ppm-sec. To determine the average concentration from the Simplex model over a one hour time period (for compatibility with a particular short-term standard), the dosage must be divided by 3,600 seconds.

A more detailed explanation in the use of the Simplex 'A' model and a program listing can be obtained from the Federal Aviation Administration's Office of Environment and Energy.

An advanced version of this model which has been expanded to accommodate line, point and area sources is under joint development by the U.S. Air Force and the FAA. This complex source model, which has

been programmed for a microcomputer, is interactive and able to accept source and receptor coordinates graphically. This model is identified as the Graphical Input Microcomputer Model (GIMM).[5]

Complex Sources

A Gaussian-Plume Algorithm for Point, Area, and Line Sources (PAL)[6]

PAL is a multi-source computerized Gaussian-Plume atmospheric dispersion algorithm for estimating concentrations of non-reactive pollutants. Concentration estimates are based on hourly meteorology data and averages can be computed for averaging times from 1 to 24 hours. Six source types are included in PAL: point, area, two types of line sources, and two types of curved path sources.

The treatment of point sources in PAL is similar to that in many other air quality simulation models. In order to calculate plume rise and dispersion, the stack gas temperature in combination with stack gas volume flow, or stack inside diameter and stack gas velocity are required.

Area sources may be squares or rectangular in nature but their boundaries must have a specific orientation. There are no special restrictions about source size. Source information needed for analysis are area source strength (concentration density) and size.

The two types of line sources are the horizontal and the specialized line sources. Line sources of finite horizontal extent, either single or multiple lanes of traffic, can be considered by PAL. In order to compute a 1-hour average, the line source strength, number of lanes, and length of roadway must be obtained.

The specialized line source subroutine is used to compute impacts from runways or taxiways. It takes into account a changing effective height of source from one end of the source to the other. It will also consider variations of the emission rate from one end of the source to the other. The data required for this part of the analysis consists of an emission rate, height at each end of the source, length of source, and speed at each end.

---

5 Segal, H.M., Microcomputer Graphics in Atmospheric Dispersion Modeling (scheduled to be published in the March or April 1983 issue of the Journal of the Air Pollution Control Association).

6 See Reference 7 in Annotated Reference List in Section V.

The two types of curved path sources are similar to the two types of line sources, and include a horizontal curved source and a specialized curved source. The input for each is the same at the horizontal line sources with the exception of allowing the source to operate on a curve with a constant radius.

The input source strength for a specialized line source (runway) is expressed in units of gm/sec; the resultant concentration from aircraft is in gm/m^3.

Airport Vicinity Air Pollution Model (AVAP)[7]

The Airport Vicinity Air Pollution Model is a complex computer model for a civil aircraft analysis. This model is unique in that it incorporates an extensive airport source emission model. However, considerable expertise and time are required to obtain and enter this source data.

Hourly average pollutant concentrations are computed for a predetermined number of 24-hour cycles using hourly meteorological data and emission data. The concentrations are computed for selected individual receptors or a grid of uniformly spaced receptors. The contributions of three distinct source classes are computed for each pollutant species by performing an emission inventory for each source. These classes are aircraft sources, non-aircraft airport sources and environ sources. A summary report is tabulated and printed at the end of each 24-hour period. It tabulates, for each receptor location and pollutant species, the 24-hour average concentration due to each source class as well as the average total concentration.

This approach will show which source class is contributing the most to any one point, thereby focusing on areas of possible mitigation.

This model was developed through FAA's Research and Development efforts and is explained in more detail in the appropriate reference in Section I.

Air Quality Assessment Model (AQAM)

The Air Quality Assessment Model (AQAM) is similar to the Airport Vicinity Model and is used for military operations. It provides for up to fifty aircraft types and a complete array of mobile and stationary ground sources. It uses Gaussian point, line and area source dispersion equations

[7] See Reference 17 in the Annotated Reference List in Section V.

Line Source Models

The most commonly used computer models in assessing air quality impacts from highway segments are:

- The California Line Source Model (CALINE)
- The Highway Air Pollution Model (HIWAY)

The California Line Source Model (CALINE)[8]

This computer model was designed to predict carbon monoxide concentrations using a mechanical mixing cell. The model treats the region directly over the highway as a zone of uniform emissions and turbulence. This zone of emission mixing and turbulence is caused by the motion of the vehicles with winds parallel to the highway alignment.

Beyond the mixing cell, the Gaussian line dispersion formula is used in several different forms, depending on highway design, relative elevations of sources and receptors, and wind orientation to reliably predict pollutant concentrations for receptors located within 150 meters of the roadway.

This program can be used to estimate carbon monoxide concentrations due to highway facilities based on traffic forecasts, vehicle mix, distance from the road and local meteorology.

The version of CALINE currently being used is known as the CALINE 3 model. This program is also available for use on a programmable hand calculator.

The Highway Air Pollution Model (HIWAY)[9]

The HIWAY computer model is a steady-state Gaussian model that determines pollution concentrations downwind for at-grade and cut-section situations that are located in relatively uniform terrain. Hourly pollution concentrations at downwind receptor points are found by trapezoidal integration of the pollutant concentrations produced by a number of point sources placed at equal intervals along the line source. This spacing is successively halved until the total concentration at a receptor point does

---

[8] See Reference 23 in the Annotated Reference List in Section V.

[9] See Reference 5 in the Annotated Reference List in Section V.

not change significantly by further halving of the spacing between point sources. This model can be used for any wind direction, any highway orientation, and any receptor location.

The input to HIWAY consists of identification information, highway parameters, emissions from each lane (grams/m-sec), and meteorological and receptor information.

The HIWAY version that is currently in use is identified as HIWAY 2.

In addition to these computer models there are also manual methods available to assess air quality impacts from highway segments. These procedures are described in the text "Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources"[10] and in a CALINE 3 graphical metnodology.[11]

An indirect source as used in this guideline is any facility that attracts mobile source activity with carbon monoxide (CO) emissions. These guidelines provide a comprehensive manual methodology to assess both the one and eight hourly CO impact.

This methodology encompasses a three part procedure. First, the physical characteristics of the roadway/parking area network and the projected traffic demand volume are used to determine various aspects of the traffic flow. Second, these traffic features, together with other ambient parameters are used to determine accompanying modal CO emission rates. Third, these emissions are inputed to an atmospheric dispersion analysis that considers variations in source type, wind speed and direction, stability, road/receptor orientation, and terrain roughness. The evaluation procedure is simplified using a series of annotated work sheets, graphs and tables.

Area Sources

In addition to line source, automotive emissions will also be generated in parking areas including both elevated garages and at-grade lots. These emissions will also need to be assessed and their potential impact analyzed.

---

[10] See Reference 15 in the Annotated Reference List in Section V.

[11] CALINE 3: A Graphical Methodology and Procedure for CO Concentrations Near Roadways, FHWA, December 1980.

There is a provision within the PAL program to analyze parking lot emissions. The data requirements as well as the output concentrations are discussed in the previous section. Parking lot emissions can also be analyzed using the methodologies and procedures contained in "Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources."

Point Sources

Point sources, while not collectively a major pollutant source at airport facilities, may need to be addressed.

The following three EPA point source computer models use Briggs' plume rise methods[12] and Pasquill-Gifford dispersion methods described in the Workbook of Atmospheric Dispersion to calculate hourly concentrations for stable pollutants. The three point source models are:

PTMAX

This program performs an analysis of the maximum short-term concentration from a single point source (stack) as a function of stability and wind speed. Required inputs to the program include ambient air temperature, emission rate, physical stack height, and stack temperature; either stack gas volume flow or both the stack gas velocity and inside diameter at the top are required. The program computes effective height of emission, maximum ground level concentration, and distances of maximum concentration for each condition of stability and wind speed.

PTDIS

This program calculates ground-level concentrations for various downwind distances for specified meteorology. Input requirements include both source and meteorological conditions. The primary output of the program consists of a table with height of emission, concentration for each downwind distance, values of dispersion parameters for each distance, and a relative concentration normalized for wind speed and source strength.

---

11 Briggs, G.A., "Plume Rise" TID-25075, Division of Technical Information, Atomic Energy Commission, Oak Ridge, Tennessee, 1969.

PTMTP

This program calculates hourly concentrations at up to 30 receptors from up to 25 point sources. Required inputs to the program consist of the number of sources to be considered, the emission rate, physical height, stack gas temperature, volume flow or stack gas velocity and diameter, and the stack locations. The number and location of receptors, as well as their height above ground are also required. Concentrations for a number of hours up to 24 can be estimated, and an average concentration over this time period is calculated. The hourly meteorological information required consists of wind direction and speed, stability class, mixing height, and ambient air temperature.

There is also a subprogram within the PAL model that use similar methodology as discussed above to compute pollutant concentrations from point sources. All the above models compute short-term concentrations while the following program, the Climatological Dispersion Model (CDM), computes long-term pollutant concentrations.

CDM

The Climatological Dispersion Model computes long-term (seasonal or annual) concentrations of quasi-stable pollutants at any ground level receptor, using average emission rates from point and area sources and a joint frequency distribution of wind direction, wind speed, and stability for the same period. Two pollutants may be considered simultaneously, the most frequent application being for sulfur dioxide and particulate matter.

Other Point Sources

In addition to stacks, stationary source emissions occur from fuel handling and storage. These emissions are the result of the evaporation of liquid from storage tanks during the daily temperature fluctuations and from the displacement of fuel vapors when tanks are filled. The first example is called the breathing loss and the second is termed the working loss.

Breathing loss is a function of the type of storage tanks, the daily temperature cycle, wind speed, fuel vapor pressure and a number of other very specific variables dependent on the type of fuel being stored. Working losses consist of hydrocarbon vapor expelled from the tank as a result of emptying or filling operations. Filling losses represent the amount of vapor (approximately equal to the volume of liquid input) that is vented to the atmosphere through displacement. After liquid is removed, emptying losses occur, because air drawn in during the operation results in growth of the vapor space.

The American Petroleum Institute has developed empirical formulae, based on extensive testing, that correlate breathing, working and standing storage losses with the physical parameters of each type of storage tank. These equation are contained in "Compilation of Air Pollutant Emission Factors," AP-42 published by the U.S. Environmental Protection Agency.

USE OF SENSITIVE AREAS AND RECEPTORS

The locations at which concentrations are monitored or for which they are estimated are known as receptors. Generally receptors should be located where, (1) the maximum total projected concentration is likely to occur, (2) the general public or any significant segment thereof is likely to have access over time periods specified by the NAAQS or (3) a sensitive area located near or adjacent to a airport facility. Examples of sensitive areas are residences, hospitals, rest homes, schools and playgrounds.

The number of receptor points chosen for analysis will determine the amount of effort and time that will be needed to assess the impact of the proposed project. If too few are chosen then the analysis will not accurately portray the pollutant concentrations that should be expected, but if too many are selected then unneeded and repetitive computations will be completed. One must select the least number of receptor points that will adequately show the expected impacts of the proposed action.

Another factor affecting the number and location of receptor points is the findings of some recent Federal Aviation Administration air quality research projects. These studies concluded that the air quality impact of aircraft emissions is small at populated locations relative to the NAAQS. The major contributor to pollutant concentrations is usually attributed to automobile emissions at passenger pick-up or discharge points and in parking areas.

These are the areas that need to be closely analyzed. Auto emission analysis is best made with microscale models, such as HIWAY 2, since they are designed for accurate pollution predictions at close-in locations (less than 100 meters). Thus, more receptor points should be located in areas influenced by auto emissions or in areas influenced by both auto and aircraft emissions. By determining what areas have the greatest potential for pollutant violations, the scope and detail of the analysis procedures can be focused in the real impact areas.

USE OF MODELS TO SIMULATE CONDITIONS IMPLIED IN AMBIENT AIR QUALITY STANDARDS

The air quality models previously discussed were developed to meet a variety of needs. Clearly, no single model is suited to assess all possible applications of a particular type of emission source. Complex source models such as PAL, AVAP and AQAM represent performance compromises to accommodate the need to assess the impact of line, point, area and accelerating aircraft sources simultaneously.

The air quality analysis problems encountered in the microscale environment are closely related to the dominant chemical and phyical processes at that scale. Because the temporal and spatial scales are small compared to the mesoscale environments, the range of air quality problems is somewhat narrow. The microscale analysis centers on the determination of ground level pollutant concentrations at receptors downwind of roadways, parking lots, runways and similar pollutant sources. In a mesoscale analysis, the emission burden from a facility is computed and its effect on the regional pollutant levels are determined.

As stated previously, several types of models have been developed to analyze transportation related emissions. The simplest is the roll back model, in which the percent increase (decrease) in future pollutant concentrations at a receptor is assumed to be proportional to the increase (decrease) in emissions. Although rollback is easy to use, concentration data at key receptors under worst conditions must be available. Moreover, rollback is based on the assumption that the emission source distribution does not change spatially or temporarily in future years. Due to these limitations and the availability of alternative models, rollback is not ordinarily the recommended approach.

The Gaussian model concept is the most widely used technique in analyzing transportation impacts. A number of line source models have been developed and applied to a variety of situations, mostly in urban areas. These models focus on single and multiple point, line, and area sources for both short- and long-term averaging periods.

All the models introduced earlier have a potential application in all airport facilities. The decision as to which model is best suited to the problem at hand is based largely upon the project scale and the extent to which the model's procedures properly account for the physical and meteorological conditions that are present.

SECTION IV

SECTION IV: SAMPLE PROBLEMS

This section provides four sample airport situations for which an air quality assessment is required. The purpose of this section is to demonstrate the application of the assessment procedures and techniques to the specific situations. The steps identified in the samples can be correlated to those shown in the Assessment Flow Chart presented earlier.

SCENARIO NO. 1 - GENERAL AVIATION AIRPORT

BACKGROUND AND PROJECT DESCRIPTION

A general aviation utility airport owned by the County is located in a rural area and has a single runway 3,400 feet in length. The airport is surrounded primarily by farmland, but a campground is located nearby (see Figure IV-1).

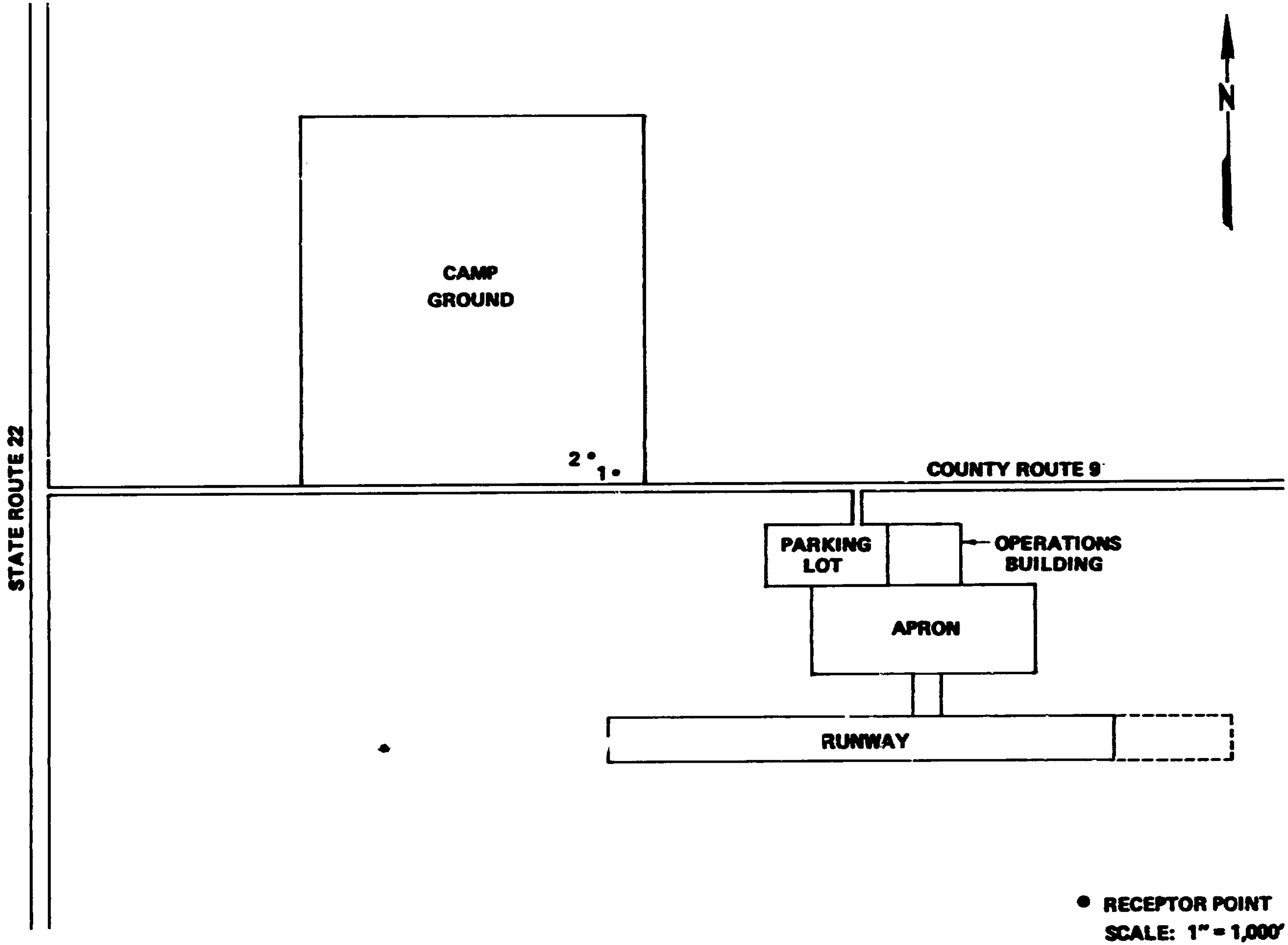
It is proposed that the runway be extended from 3,400 feet to 4,200 feet to accommodate a larger percentage of the business jet fleet. The auto parking would also be expanded to 200 spaces. General operational data is provided below.

Average Daily Aircraft Operations

Aircraft Type	Existing	1985	1995
Business Jet	12	18	26
Twin-Engine Piston	80	110	140
Single-Engine Piston	200	290	380
Annual Operations	166,000	205,000	212,000

Average Daily Traffic (ADT) and Peak Hour Traffic Summary

Study Year	Airport Traffic		Through Traffic on County Road	
	ADT	Peak-Hour	ADT	Peak-Hour
Existing	190	25	1,400	182
1985	250	32	1,600	208
1995	430	56	2,300	299



BASIC LAYOUT PLAN
AIR QUALITY ANALYSIS

Figure IV–1

EVALUATION PROCEDURES[1]

Block 1-1 - The project was identified as a runway extension. The increases in aircraft operations and ground traffic has the potential for increasing ambient pollutant levels.

Block 1-2 - The airport project is located in a state that does not have Indirect Source Review. Blocks 1-3 and 1-4 can be bypassed. The next level of review is based on the type of aircraft activity generated by the facility, Block 1-5. The facility is a general aviation facility with annual operations exceeding 180,000.

Block 1-8 - Using available operational data, an emission inventory of daily pollutional load was determined for the airport. (For the purpose of this sample, only computations for the existing year and 1985 will be shown.) The first step in the inventory was to derive the time spent by each aircraft type in each operating mode. By evaluating local aircraft performance and ground operating times, the time in mode selected for this analysis are given below:

Time in Mode

(Minutes)

Aircraft Type	Taxi-Idle (Existing)	Taxi-Idle 1985	Take-Off	Climbout	Approach
Business Jet	10	11	0.4	0.5	1.6
Twin-Engine Piston	13	14	0.3	5.0	6.0
Single Engine Piston	13	14	0.3	5.0	6.0

[1] Block numbers refer to Assessment Procedure Flow Charts in Section II.

In order to obtain the daily pollution total (lbs) for each pollutant for each aircraft type, the sum of the respective modal emission factors (from AP-42) times each time in mode is multiplied by the aircraft's number of engines and its number of landing-takeoff cycles (LTO's) per day. These computations are shown first for the existing conditions at the airport.

EXISTING CONDITIONS

Business Jet - Engine GA TPE 731-2

$$CO:\ [(11.11 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (1.86 \times \frac{0.4}{60}) + (1.80 \times \frac{0.5}{60}) +$$

$$(9.53 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 6 \text{ LTO's} = 25.6 \text{ lbs/day}$$

$$HC:\ [(4.05 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.14 \times \frac{0.4}{60}) + (0.12 \times \frac{0.5}{60}) +$$

$$(1.51 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 6 \text{ LTO's} = 8.6 \text{ lbs/day}$$

$$NO_x:\ [(0.54 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (29.8 \times \frac{0.4}{60}) + (23.68 \times \frac{0.5}{60}) +$$

$$(3.59 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 6 \text{ LTO's} = 7.0 \text{ lbs/day}$$

$$SO_x:\ [(0.18 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (1.55 \times \frac{0.4}{60}) + (1.39 \times \frac{0.5}{60}) +$$

$$(0.52 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 6 \text{ LTO's} = 0.8 \text{ lbs/day}$$

Twin-Engine Piston - Engine CON TS 10-360C

$$CO:\ [(6.81 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (143.9 \times \frac{0.3}{60}) + (95.5 \times \frac{5.0}{60}) +$$

$$(60.7 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 40 \text{ LTO's} = 1{,}279 \text{ lbs/day}$$

HC: $[(1.59 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (1.22 \times \frac{0.3}{60}) + (0.95 \times \frac{5.0}{60}) +$

$(0.69 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 40 \text{ LTO's} = 40 \text{ lbs/day}$

NO_x: $[(0.022 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (0.36 \times \frac{0.3}{60}) + (0.43 \times \frac{5.0}{60}) +$

$(0.23 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 40 \text{ LTO's} = 5.2 \text{ lbs/day}$

SO_x: $[(0.0 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (0.03 \times \frac{0.3}{60}) + (0.02 \times \frac{5.0}{60}) +$

$(0.01 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 40 \text{ LTO's} = 0 \text{ lbs/day}$

<u>Single Engine Piston - Engine CON 0-200</u>

CO: $[(5.31 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (44 \times \frac{0.3}{60}) + (44 \times \frac{5.0}{60}) +$

$(30.29 \times \frac{6.0}{60})] \times 1 \text{ engine} \times 100 \text{ LTO's} = 807 \text{ lbs/day}$

HC: $[(0.239 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (0.940 \times \frac{0.3}{60}) + (0.940 \times \frac{5.0}{60}) +$

$(0.847 \times \frac{6.0}{60})] \times 1 \text{ engine} \times 100 \text{ LTO's} = 22 \text{ lbs/day}$

NO_x: $[(0.013 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (0.22 \times \frac{0.3}{60}) + (0.22 \times \frac{5.0}{60}) +$

$(0.029 \times \frac{6.0}{60})] \times 1 \text{ engine} \times 100 \text{ LTO's} = 2.5 \text{ lbs/day}$

SO_x: $[(0.0 \text{ lbs/hr} \times \frac{13 \text{ minutes}}{60 \text{ min/hr}}) + (0.01 \times \frac{0.3}{60}) + (0.01 \times \frac{5.0}{60}) +$

$(0.01 \times \frac{6.0}{60})] \times 1 \text{ engine} \times 100 \text{ LTO's} = 0 \text{ lbs/day}$

Summary of Aircraft Pollutant Inventory (lbs/day)
Existing Condition

	CO	HC	NO_x	SO_x	Total
Business Jet	25.6	8.6	7.0	0.8	42.0
Twin-Engine	1,279.0	40.0	5.2	0.0	1,324.2
Single Engine	807.0	22.0	2.5	0.0	831.5
Total	2,111.6	70.6	14.7	0.8	2,197.7

The procedures used for 1985 computations would be the same as those used for Existing Conditions. The taxi-idle times would change but all other mode times would remain the same. For 1985, a heavier class of Business Jets would be used with the aforementioned piston-type aircraft. The 1985 computations are provided for the Business Jets along with the 1985 Summary Table.

1985 CONDITIONS

Business Jet - Engine GE CJ610-2C

$$\text{CO:}\quad [(79.05 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (75.06 \times \frac{0.4}{60}) + (65.61 \times \frac{0.5}{60}) +$$

$$(90.20 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 9 \text{ LTO's} = 314.8 \text{ lbs/day}$$

$$\text{HC:}\quad [(9.18 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (0.28 \times \frac{0.4}{60}) + (0.49 \times \frac{0.5}{60}) +$$

$$(2.77 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 9 \text{ LTO's} = 31.7 \text{ lbs/day}$$

$$NO_x: \ [(0.46 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (11.68 \times \frac{0.4}{60}) + (8.99 \times \frac{0.5}{60}) +$$

$$(1.54 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 9 \text{ LTO's} = 5. \text{ lbs/day}$$

$$SO_x: \ [(0.51 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (2.78 \times \frac{0.4}{60}) + (2.43 \times \frac{0.5}{60}) +$$

$$(1.03 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 9 \text{ LTO's} = 2.9 \text{ lbs/day}$$

Summary of Aircraft Pollutant Inventory (lbs/day)
1985 Condition

	CO	HC	NO_x	SO_x	Total
Business Jet	314.8	31.7	5.0	2.9	354.4
Twin-Engine	1,797.4	57.2	7.3	0.3	1,862.2
Single Engine	1,154.2	31.9	3.5	0.3	1,189.9
Total	3,266.4	120.8	15.8	3.5	3,406.5

The next step in the inventory was to compute the daily total pollutional loading from site-generated vehicular traffic. Emission totals were computed for existing and 1985 traffic projections. Emission rates for motor vehicles were determined from the EPA publication Mobile Source Emission Factors and the accompanying MOBILE 1 computer program. Projected traffic volumes, the associated vehicle miles of travel, and the average travel speed are denoted in the computations. The basic equation for computing the vehicle emissions is given as:

Pollutant Loading (gm/day) = Average Daily Traffic (veh/day) x
Length of Roadway (miles) x
Emission Factor[2] (gm/mile)

Basic data includes:

- Existing Site-Generated Traffic = 190 veh/day
  250 veh/day in 1985

- Length of Roadway - County Route 9 from State Route 22 to airport entrance = 1 mile

- Average Travel Speed = 40 mph
  35 mph in 1985;

- Emission Factors - CO = 29.77 gm/mile
  22.46 gm/mile in 1985

  HC = 3.55 gm/mile
  2.24 gm/mile in 1985

  NO_x = 4.09 gm/mile
  3.17 gm/mile in 1985

  SO_x = 0.23 gm/mile
  0.23 gm/mile in 1985

  Part = 0.60 gm/mile
  0.60 gm/mile in 1985

EXISTING CONDITION

CO: 190 veh/day x 1 mile x 29.77 gm/mile = 5,656.3 gm/day or 12.47 lb/day

HC: 190 veh/day x 1 mile x 3.55 gm/mile = 674.5 gm/day or 1.49 lb/day

NO_x: 190 veh/day x 1 mile x 4.09 gm/mile = 777.1 gm/day or 1.71 lb/day

---

2 Emission Factors for CO, HC, NO_x from MOBILE 1; SO_x and Particulate Emission Factors from "Compilations of Air Pollutant Emission Factors" (AP-42) Table 3.1.1-2.

SO_x: 190 veh/day x 1 mile x 0.23 gm/mile = 43.7 gm/day or 0.10 lb/day

Part: 190 veh/day x 1 mile x 0.60 gm/mile = 114.0 gm/day or 0.25 lb/day

1985 CONDITION

CO: 250 veh/day x 1 mile x 22.46 gm/mile = 5,615 gm/day or 12.38 lb/day

HC: 250 veh/day x 1 mile x 2.24 gm/mile = 560 gm/day or 1.23 lb/day

NO_x: 250 veh/day x 1 mile x 3.17 gm/mile = 792.5 gm/day or 1.75 lb/day

SO_x: 250 veh/day x 1 mile x 0.23 gm/mile = 57.5 gm/day or 0.13 lb/day

Part: 250 veh/day x 1 mile x 0.60 gm/mile = 150.0 gm/day or 0.33 lb/day

Summary of Existing Inventory (lbs/day)

	CO	HC	NO_x	SO_x	Particulates	Total
Aircraft	2,111.8	70.6	14.7	0.8	---	2,197.9
Vehicular Traffic[3]	12.5	1.5	1.7	0.1	0.2	16.0
Total	2,124.3	72.1	16.4	0.9	0.2	2,213.9

[3] Includes passenger, visitor and employee traffic.

Summary of 1985 Inventory (lbs/day)

	CO	HC	NO_x	SO_x	Particulates	Total
Aircraft	3,266.4	120.8	15.8	3.5	---	3,406.5
Vehicular Traffic[4]	12.4	1.2	1.7	0.1	0.3	15.7
Total	3,278.8	122.0	17.5	3.6	0.3	3,422.2

Block 1-9 - After the emission inventory was completed, a meeting was scheduled with the State Air Quality Review Board. Prior to the meeting, a review of State air quality regulations was accomplished.

At the meeting, the project's scope and our emission inventory data were discussed in relationship to regional activity and pollutant levels. The existing and projected 1985 total project emissions were acknowledged as relatively small when compared to the regional totals.

The State Review Board was also required to evaluate the project's conformity with the SIP. The Review Board, while recognizing the level of the project's emission inventory, requested additional air quality analysis in order to determine consistency and conformity with the SIP. The Board wanted a determination study done of the carbon monoxide (CO) pollutant concentrations which might occur at the camp ground opposite the airport. After further discussion, locations for two receptor points were chosen for a dispersion analysis.

Block 1-11 - The major sources at the airport for the dispersion analysis would be the runway, parking lot, and the access roadway. These are typical line and area sources. There are no major point sources at the airport to be considered. The State Implementation Plan and other air quality regulations were reviewed for special consideration like Indirect Source Review procedures or the existence of local/regional strategies. These regulations could influence the type and depth of analysis that would have been necessary; however, no special requirements existed for the project area.

---

[4] Includes passenger, visitor and employee traffic.

For this analysis, the Simplex 'A' program was used for runway carbon monoxide dispersion (see Section III) and the methodologies presented in the "Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9" were used for dispersion from the parking lot and the roadway.

This example presents the one-hour dispersion analysis for 1985, which represents the first year under proposed project conditions. The data inputs for the Simplex 'A' programmable calculator program for Receptor Point 1 (Receptor Point 2) are:

Downwind Distance	-	$x = 731$ m (628 m)
Crosswind Distance	-	$y = 91$ m (122 m)
Standard Deviation of Plume Concentration in Vertical Direction	-	$\sigma_z = 8$ m
Standard Deviation of Plume Concentration in Crosswind Direction	-	$\sigma_y = 16$ m
Wind Speed	-	$U = 1.0$ m/sec
Height of Emissions	-	$H = 4$ m
Total Emissions as Computed Below		$= Q_t$

Q_t is determined by adding the emissions (grams/sec) of each aircraft for the busiest hour of operation:

$$Q_t = [(2.13 \frac{\text{lb}}{\text{LTO-engine}} \times 2 \text{ engines (jet)} \times \frac{1 \text{ LTO}}{\text{hr}} \times \frac{1 \text{ hr}}{3{,}600 \text{ sec}} \times \frac{454 \text{ gm}}{\text{lb}}) +$$

$$(15.99 \times 2 \text{ (twin)} \times 5 \times \frac{1}{3{,}600} \times 454) +$$

$$(8.07 \times 1 \text{ (single)} \times 12 \times \frac{1}{3{,}600} \times 454)] = 32.91 \text{ gm/sec}$$

Using the input data above for Receptor Point 1, the Simplex 'A' results are 20.05 ppm-sec, 19.25 ppm-sec and 18.55 ppm-sec for the three iterative values along the runway. These numbers are summed and then divided by 3,600 seconds/hr to obtain the hourly concentration:

$$20.05 + 19.25 + 18.55/3,600 = 0.016 \text{ ppm}$$

For Receptor Point 2, the program results are 19.05 ppm-sec, 18.31 ppm-sec and 17.66 ppm-sec.

$$19.05 + 18.31 + 17.66/3,600 = 0.015 \text{ ppm}$$

The dispersion procedures discussed in Volume 9 utilizes a series of annotated worksheets, graphs and tables to analyze the pollutant concentrations generated by the roadway/parking area network. The work-sheets showing the data and analysis procedures are on the following pages.

Worksheet 1

TRAFFIC INFORMATION USED IN THE APPLICATION OF THE EVALUATION PROCEDURE

1.	Road segment or intersection approach identification	1E-W
2.	Observed 1-hr volume (vph)	
	Observed 8-hr volume (vph)	
	Projected 1-hr peak demand (vph)	420
	Projected 8-hr peak demand (vph)	
3.	Percentage cold starts	
4.	Percentage trucks and buses	20
5.	Metropolitan population	
6.	Slope	
7.	Free-flow parameters	
	Number of lanes	2
	Average lane width (ft)	12
	Design speed (mph)	50
	Highway type (see Figures 2-5)	2 Lane Rural
8.	Intersection parameters	
	Intersection designation	
	Approach width (ft)	
	Percentage right turns	
	Percentage left turns	
	Type control and description of signal controller	
9.	Area source parameters	
	Parking lot gate designation	1N
	Projected 1-hr peak entrance demand (vph)	60
	Projected 1-hr peak exit demand (vph)	60
	Projected 8-hr peak entrance demand (vph)	
	Projected 8-hr peak exit demand (vph)	
	Parking lot area (m^2)	3,500
	Parking lot capacity (veh)	100
	Running time required to access auxiliary parking (s)	—
	Facility emptying time	—
	Average cars per stall	—
	Average area per stall (m^2)	30

SOURCE: Guidelines for Air Quality Maintenance Planning and Analysis. Volume 9: Evaluating Indirect Sources.

WORKSHEET B—CAPACITY ANALYSIS (see instructions following)

Step	Symbol	Input/Units	
1	i	<u>Road segment (or approch) designation</u>	1E-W
2		<u>Free flow capacity computation:</u>	
2.1	M_i	Number of lanes	.5
2.2	W_f	Adjustment for lane width (Table B-1)	1.00
2.3	T_i	Adjustment for trucks (Table B-2)	0.83
2.4	C_i	Free flow capacity	870
3		<u>Signalized intersection capacity:</u>	
3.1	j	Green signal phase identification	
3.2	Wa_i	Approach width with parking (ft)	
3.3		Percent right turners	
3.4		Percent left turners	
3.5		Metropolitan area size	
3.6	$Cs_{i,j}$	Capacity service volume (vph of green)	
4		<u>Signalized intersection green phase and cycle length:</u>	
4.1	$V_{i,j}$	Demand volume for approach and phase	
4.2	$V_{i,j}/Cs_{i,j}$	Volume to green capacity ratio	
4.3	approx G/Cy	Approximate G/Cy	
4.4	$\sum_j \max(V_{i,j}/Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase	
4.5	Cy	Signal cycle time (sec)	
4.6	Gj	Green phase length	
4.7	Gj/Cy	Green phase to cycle time ratio	
4.8	$C_{i,j}$	Capacity for approach i phase j	
5		<u>Two-way stop, two-way yield or uncontrolled intersection:</u>	
5.1	$V_m + V_n$	Major street two-way volume	
5.2	C_i	Cross street capacity	
6		<u>Four-way stop intersections:</u>	
6.1	V_i	Approach volume	
6.2	Spi	Demand split on cross streets	
6.3	C_i	Capacity of approach	
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop	

WORKSHEET 2--LINE SOURCE EMISSION RATE COMPUTATION
(see instructions following)

Project No.: 1985 **Analyst:** ____________

Site: Sample Airport #1 **Date:** 1981

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	E-W			
2	V_i	Demand volume (vph)	240			
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	35			
5	Ef_i	Free-flow emissions (g/veh-m)	.013			
6.1	N_i	Number of lanes in approach i				
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)				
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)				
6.5	C_y	Signal cycle length (s)				
6.6	$G_{i,j}$	Green phase length for approach i phase j (s)				
6.7	C_i	Capacity of approach i (vph)				
6.8	$P_{i,j}$	Proportion of vehicles that stop				
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle				
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase				
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)				
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	Excess emissions from acceleration (g/veh-m)				
11	Ed_i	Excess emissions from deceleration (g/veh-m)				
12	Qad_i	Excess emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fr_i	Average idling emission rate (g/s)				
16	Qe	Average excess emission rate (g/m-s)				
17	Qe'_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m) *	.000931			

* Computed using Emission Factor from MOBILE 1 instead of C_t and Line 5.

$$22.46\ \frac{\text{gm}}{\text{mile}} \times 240\ \frac{\text{veh}}{\text{hr}} \times \frac{1}{3,600}\ \frac{\text{hr}}{\text{sec}} \times \frac{1}{1,609}\ \frac{\text{mile}}{\text{meter}} = .000931\ \frac{\text{gm}}{\text{m-sec}}$$

WORKSHEET 3--AREA SOURCE EMISSIONS COMPUTATION
(see instructions following)

Project No.: 1985 Analyst: ______

Site: Sample Airport #1 Date: 1981

Step	Symbol	Input/Units				
1	Brt	Base running time	____	____	____	____
1.1		Base approach time(s)	____			
1.2		Base entrance time(s)	____			
1.3		Base movement-in time(s)	____			
1.4		Base stop, base start time(s)	____			
1.5		Base movement-out time(s)	____			
1.6		Base exit time(s)	____			
1.7		Base departure time(s)	____			
1.8		Total base running time(s)	240			
2	A	Area of parking lot (m^2)	3,500			
3	i	Entrance approach identification	1N	____	____	____
4	Ve_i	Entrance demand volume (vph)	60	____	____	____
5	Ce_i	Entrance approach capacities (vph)	870	____	____	____
6	i	Exit approach identification	1N	____	____	____
7	Vx_i	Exit demand volume (vph)	60	____	____	____
8	Cx_i	Exit approach capacities (vph)	870	____	____	____
9		Number of parking spaces occupied	87			
10	F	Emissions*	.29	____	____	____
11	Pc	Capacity of parking lot (veh)	100			
12	Rmi	Excess movement-in time(s)	____			
13	Fet	Facility emptying time(s)	____			
14		Excess running time	____			
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio	0.11	____	____	____
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio	0.11	____	____	____
14.3	Re_i	Excess running time entering parking lot	0.11	____	____	____
14.4	Rx_i	Excess running time exiting parking lot	0.11	____	____	____
15	Te_i	Total entering running time (s/veh)	120	____	____	____
16	Rmo	Excess running time moving out of parking stalls (s/veh)	____			
17	Tx_i	Total exiting running time (s/veh)	120	____	____	____
18	Qa	Total emission rate from a parking lot ($g/m^2 - s$)	0.000331			
19	Qa'	Area source emission rate without the emissions from internal road segment, i	____			

* Use Idle Emission Factor from MOBILE 1.

$$17.59 \frac{gm}{min} \times \frac{1 \ min}{60 \ sec} = .29 \frac{gm}{sec}$$

WORKSHEET 4--INFINITE LINE SOURCE CO DISPERSION ANALYSIS (see instructions following)

Project No.: 1985 Analyst ________

Site: Sample Airport #1 Date: 1981

Step	Symbol	Input/Units	Identification	Traffic Stream			
		Basic inputs		RP1		RP2	
1	SC	Stability class		F		F	
2	$\bar{U}$	Wind speed (m s^{-1})		1.0		1.0	
3	θ	Wind/road angle (deg)		112.5		112.5	
4		Sin θ		.924		.924	
5	x	Road receptor distance (m)		15		25	
6	σ_{z_o}	Initial dispersion (m)		1.5		1.5	
7	Q	Emission rate (g m^{-1} s^{-1})		.000931		.000931	
7a		Street canyon? (yes or no)		No			
		Dispersion computation					
8	$\chi U/Q$	Normalized concentration (10^{-3} m^{-1})		290		275	
9	χU	Normalized concentration (mg m^{-2} s^{-1})		0.27		0.26	
10	χ	CO concentration (mg m^{-3})		0.27		0.26	
11	χ	CO concentration (ppm)		0.23		0.22	
		Optional z-correction (heights other than 1.8 m above ground)					
12	z	Height receptor (m)					
13		z-correction factor					
14	χ'	CO concentration at height z (mg/m^3)					
15	χ'	CO concentration at height z (ppm)					

WORKSHEET 6--CO AREA SOURCE DISPERSION ANALYSIS
(see instructions following)

Project No.: 1985 Analyst: ____

Site: Sample Airport #1 Date: 1981

Step	Symbol	Inputs/Units	RP1		RP2	
		Basic Inputs	**Traffic Stream**			
1		Source ID	1N		1N	
2	SC	Stability class	F		F	
3	U	Wind speed ($m\ s^{-1}$)	1.0		1.0	
4	σ_{z_0}	Initial dispersion (m)	5.0		5.0	
5	x_0	Virtual dispersion distance (m)	13		13	
6	x_u	Actual upwind distance (m)	457		490	
7	$r_u = x_u + x_0$	Effective upwind distance* (m)	470		503	
8	x_d	Actual downwind distance (m)	274		307	
9	$r_d = x_d + x_0$	Effective downwind distance* (m)	287		320	
10	Qa	Emission rate ($g\ m^{-2}\ s^{-1}$)	.000331		000331	
		Dispersion Computation				
11	$(\chi U/Qa)_u$	Upwind normalized concentration	25.0×10^3		25.4×10^3	
12	$(\chi U/Qa)_s$	Downwind normalized concentration	-19.3×10^3		-20.0×10^3	
13	$\chi U/Qa$	Normalized CO concentration*	5.7×10^3		5.4×10^3	
14	Qa	Emission rate ($g\ m^{-2}\ s^{-1}$)	x.000331	x	x.000331	x
15	χU		1.89		1.79	
		Enter line 3	÷1.0	÷	÷1.0	÷
16	χ	CO concentration ($mg\ m^{-3}$)	1.89		1.79	
17	χ	CO concentration (ppm)	1.64		1.56	

*Use Table to determine $\chi U/Qs$ if r > 500 m

The results of the dispersion analysis are summarized below:

Source	Receptor Point 1	Receptor Point 2
Parking Lot	1.640 ppm	1.560 ppm
Roadway	0.230	0.220
Runway	0.016	0.015
Total	1.886	1.795
Estimated Ambient (Background) Level	4.400	4.400
	6.286 ppm	6.195 ppm

The 1-hour CO concentrations at the two receptor points are much lower than the 1-hour standard of 35 ppm. In this case, the maximum 8-hour CO concentrations can be computed by multiplying the 1-hour concentrations by a persistence factor of 0.65, a factor developed by the EPA as a result of studies conducted in major cities throughout the U.S.[5]

If the computed 1-hour CO concentrations had been at or near the 1-hour air quality standard, then a more exacting method would have been used. This method would have required the calculation of eight consecutive 1-hour concentrations for the busiest consecutive eight hours. The averaging of the eight 1-hour concentrations would have given the 8-hour concentration.

Receptor 1

1.886 x .65 = 1.23 plus background 2.60

Total = 3.83 ppm

---

[5] See Reference 15 in the Annotated Reference List.

Receptor 2

1.795 x .65 = 1.17 plus background 2.60

Total = 3.77 ppm

In this case, the 8-hour concentrations at the two receptors are also less than the 8-hour air quality standard of 9 ppm.

In addition to the assessment methods described in this section, a look-up table approach for determining air quality levels is available in cases where only cursory information is required. This method includes the use of the Mobile Source Emission Factors Tables[6] to establish emission rates for a variety of roadway vehicles and the CALINE 3 Graphical Solution Procedures[7] to determine the concentrations resulting from the emission rates determined from the Emission Factor Tables.[6]

Blocks 1-12 - The dispersion study showed that no violations of either the 1- or 8-hour standard would occur. The analysis results were finalized and summarized (Block 1-14). The study results were coordinated with and accepted by the State Air Quality Review Board as conforming to the SIP and an Air Quality Certification was issued (Block 1-16). The completed air quality assessment was included within the Environmental Assessment Report and circulated (Block 1-17).

---

6 "Mobile Source Emission Factor Tables," FHWA Technical Advisory T 6640.1, November 16, 1978, USDOT/FHWA.

7 CALINE 3 - A Graphical Solution Procedure for Estimating Carbon Monoxide (CO) Concentrations Near Roadways, December 1980, USDOT/FHWA.

SCENARIO NO. 2 - AIR CARRIER AIRPORT

BACKGROUND AND PROJECT DESCRIPTION

The Cooper County Transportation Authority proposes to build a new runway at their municipal airport to meet the expected increases in aircraft operations. The Transportation Authority also plans to expand the existing terminal and build additional parking lots to handle the expected increase in passenger traffic. The expansion of the terminal building will require an expansion of the airport power generating station (see Figure IV-2).

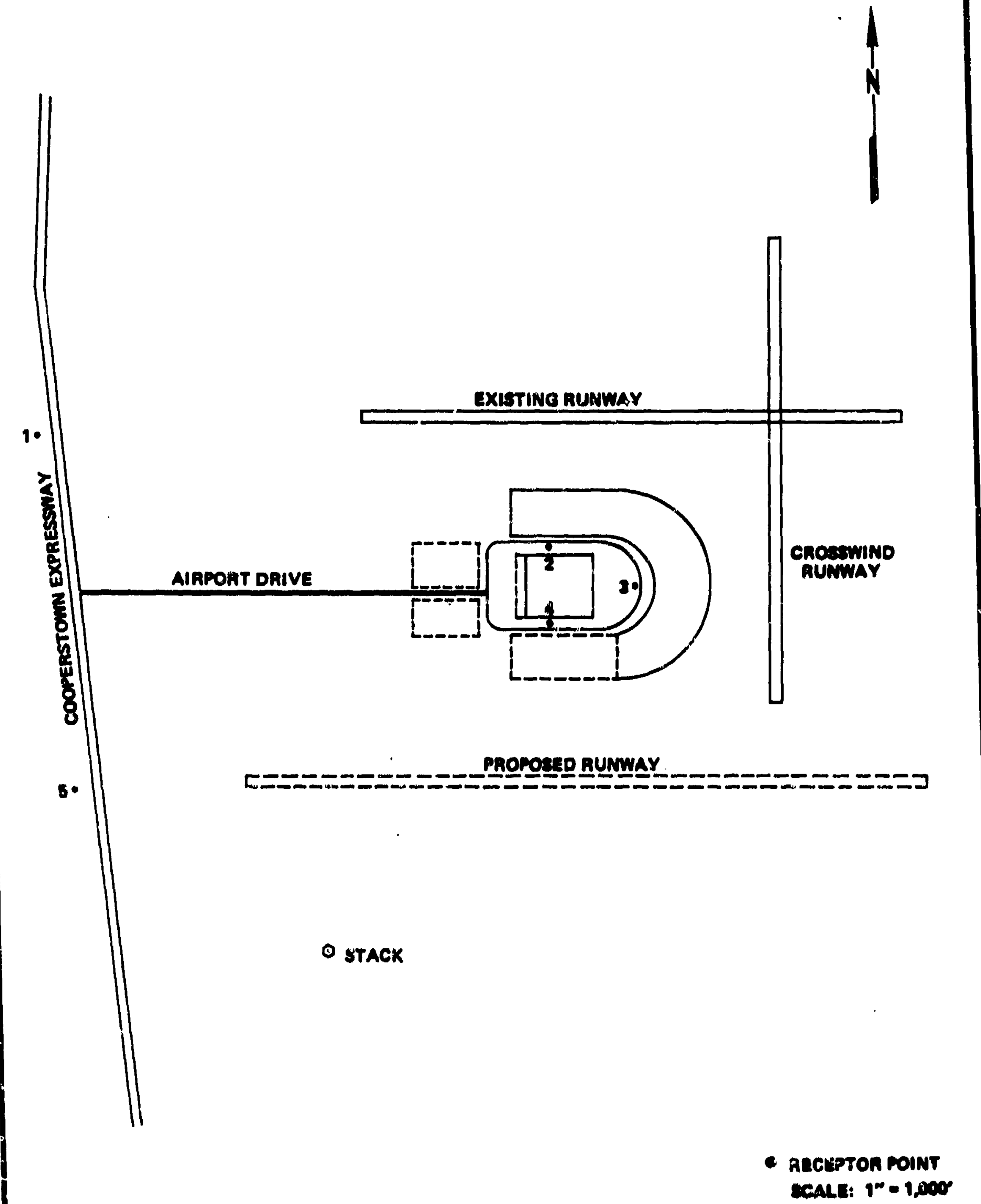
Operational data for the airport is presented below.

Average Daily Aircraft Operations

Aircraft Type	Existing	1985	1995
727	68	84	124
DC-9	38	60	96
Business Jet	8	14	22
Turboprop	6	10	18
Twin-Engine Piston	256	314	440

Airport Generated Traffic

Study Year	ADT	Peak-Hour	Annual Passengers
Existing	20,740	2,904	3,785,000
1985	25,800	3,612	4,709,000
1995	43,000	6,020	7,848,000



BASIC LAYOUT PLAN
AIR QUALITY ANALYSIS

Figure IV-2

EVALUATION PROCEDURES

Blocks 1-1 - The proposed airport expansion will increase aircraft operations 86 percent over a 14-year span with a potential of causing air quality violations.

Blocks 1-2 - There are no state Indirect Source Review regulations governing this project.

Block 1-5 - The airport is a medium size air carrier airport. The existing annual passenger enplanements for the airport are 1,892,000 passengers. It rises to 2,354,500 enplanements in 1985 and 3,924,000 enplanements in 1995. The enplanement threshold of 1,300,000 is exceeded both for existing and proposed scenarios.

Block 1-8 - The detailed analysis began with the emission inventory and the documentation of aircraft time in mode.

Time in Mode

(Minutes)

	Existing				1985	1995
Aircraft Type	Taxi-Idle	Take-Off	Climbout	Approach	Taxi-Idle	Taxi-Idle
727	11	0.7	2.2	4.0	14	16
DC-9	11	0.7	2.2	4.0	14	16
Business Jet	9	0.4	0.5	1.6	11	13
Turboprop	10	0.5	2.5	4.5	12	14
Twin-Engine Piston	10	0.3	5.0	6.0	11	13

The Take-Off, Climbout, and Approach times will be the same for each study year.

The aircraft Emission Inventory will be computed using the Modal Emission Factor (from AP-42) times the time spent in that mode and then summed for each pollutant. This number is then multiplied times the number of engines per aircraft times the number of daily LTO's as shown below for the various pollutants under existing conditions.

EXISTING CONDITIONS

727 - Engine - P&W JT8D-17

$$CO: [(39.10 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (6.99 \times \frac{0.7}{60}) + (7.91 \times \frac{2.2}{60}) + (20.23 \times \frac{4.0}{60})] \times 3 \text{ engines} \times 34 \text{ LTO's} = 907 \text{ lbs/day}$$

$$HC: [(10.10 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (0.50 \times \frac{0.7}{60}) + (0.40 \times \frac{2.2}{60}) + (1.41 \times \frac{4.0}{60})] \times 3 \text{ engines} \times 34 \text{ LTO's} = 201 \text{ lbs/day}$$

$$NO_x: [(3.91 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (202.6 \times \frac{0.7}{60}) + (123.4 \times \frac{2.2}{60}) + (19.39 \times \frac{4.0}{60})] \times 3 \text{ engines} \times 34 \text{ LTO's} = 907 \text{ lbs/day}$$

$$SO_x: [(1.15 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (9.98 \times \frac{0.7}{60}) + (7.91 \times \frac{2.2}{60}) + (2.81 \times \frac{4.0}{60})] \times 3 \text{ engines} \times 34 \text{ LTO's} = 82 \text{ lbs/day}$$

$$Part: [(0.36 \text{ lbs/hr} \times \frac{11 \text{ minutes}}{60 \text{ min/hr}}) + (3.70 \times \frac{0.7}{60}) + (2.60 \times \frac{2.2}{60}) + (1.50 \times \frac{4.0}{60})] \times 3 \text{ engines} \times 34 \text{ LTO's} = 51 \text{ lbs/day}$$

DC-9 (Using Same Procedure)

CO: 338 lbs/day

HC: 75 lbs/day

NO_x: 338 lbs/day

SO_x: 30 lbs/day

Part: 19 lbs/day

Business Jet - Engine GE CJ 610-6

CO: $[(79.05 \text{ lbs/hr} \times \frac{9 \text{ minutes}}{60 \text{ min/hr}}) + (75.06 \times \frac{0.4}{60}) + (65.61 \times \frac{0.5}{60}) +$

$(90.20 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 4 \text{ LTO's} = 122 \text{ lbs/day}$

HC: $[(9.18 \text{ lbs/hr} \times \frac{9 \text{ minutes}}{60 \text{ min/hr}}) + (0.28 \times \frac{0.4}{60}) + (0.49 \times \frac{0.5}{60}) +$

$(2.77 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 4 \text{ LTO's} = 12 \text{ lbs/day}$

NO_x: $[(0.46 \text{ lbs/hr} \times \frac{9 \text{ minutes}}{60 \text{ min/hr}}) + (11.68 \times \frac{0.4}{60}) + (8.99 \times \frac{0.5}{60}) +$

$(1.54 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 4 \text{ LTO's} = 2 \text{ lbs/day}$

SO_x: $[(0.51 \text{ lbs/hr} \times \frac{9 \text{ minutes}}{60 \text{ min/hr}}) + (2.78 \times \frac{0.4}{60}) + (2.43 \times \frac{0.5}{60}) +$

$(1.03 \times \frac{1.6}{60})] \times 2 \text{ engines} \times 4 \text{ LTO's} = 1 \text{ lb/day}$

Turboprop - Engine PT 6A-28

CO: $[(7.36 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.43 \times \frac{0.5}{60}) + (0.48 \times \frac{2.5}{60}) +$

$(4.95 \times \frac{4.5}{60})] \times 2 \text{ engines} \times 3 \text{ LTO's} = 10 \text{ lbs/day}$

HC: $[(5.77 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.0 \times \frac{0.5}{60}) + (0.0 \times \frac{2.5}{60}) +$

$(0.46 \times \frac{4.5}{60})] \times 2 \text{ engines} \times 3 \text{ LTO's} = 6 \text{ lbs/day}$

NO_x: $[(0.23 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (3.32 \times \frac{0.5}{60}) + (2.80 \times \frac{2.5}{60}) +$

$(1.80 \times \frac{4.5}{60})] \times 2 \text{ engines} \times 3 \text{ LTO's} = 2 \text{ lbs/day}$

SO_x: $[(0.12 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.43 \times \frac{0.5}{60}) + (0.40 \times \frac{2.5}{60}) +$

$(0.22 \times \frac{4.5}{60})] \times 2 \text{ engines} \times 3 \text{ LTO's} < 1 \text{ lb/day}$

Twin-Engine Piston - Engine TS IO-360C

CO: $[(6.81 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (143.9 \times \frac{0.3}{60}) + (95.6 \times \frac{5.0}{60}) +$

$(60.7 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 128 \text{ LTO's} = 4{,}068 \text{ lbs/day}$

HC: $[(1.59 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (1.22 \times \frac{0.3}{60}) + (0.95 \times \frac{5.0}{60}) +$

$(0.69 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 128 \text{ LTO's} = 108 \text{ lbs/day}$

NO_x: $[(0.022 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.36 \times \frac{0.3}{60}) + (0.43 \times \frac{5.0}{60}) +$

$(0.23 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 128 \text{ LTO's} = 16 \text{ lbs/day}$

SO_x: $[(0.0 \text{ lbs/hr} \times \frac{10 \text{ minutes}}{60 \text{ min/hr}}) + (0.03 \times \frac{0.3}{60}) + (0.02 \times \frac{5.0}{60}) +$

$(0.01 \times \frac{6.0}{60})] \times 2 \text{ engines} \times 128 \text{ LTO's} = 1 \text{ lb/day}$

Summary of Aircraft Pollutant Inventory (lbs/day)
Existing Conditions

	CO	HC	NO_x	SO_x	Particulates
727	907	201	907	82	51
DC-9	338	75	338	30	19
Business Jet	122	12	2	1	--
Turboprop	10	6	2	< 1	--
Twin-Engine Piston	4,068	108	16	1	--
Total	5,445	402	1,265	114	70

In the same manner, the aircraft emissions were totaled for 1985 and 1995 conditions.

Summary of Aircraft Pollutant Inventory (lbs/day)
1985 Conditions

	CO	HC	NO_x	SO_x	Particulates
727	1,366	311	1,145	108	40
DC-9	650	148	545	52	19
Business Jet	251	25	4	2	--
Turboprop	19	12	3	1	--
Twin-Engine Piston	5,024	141	20	1	--
Total	7,310	637	1,717	164	59

Summary of Aircraft Pollutant Inventory (lbs/day)
1995 Conditions

	CO	HC	NO_x	SO_x	Particulates
727	2,260	523	1,715	167	61
DC-9	1,166	270	885	86	29
Business Jet	453	45	6	4	--
Turboprop	38	25	6	12	--
Twin-Engine Piston	7,141	220	29	1	--
Total	11,058	1,083	2,641	270	90

The next step in the emission inventory was to determine the contribution from site-generated auto traffic.

Vehicle emission loadings were computed for existing, 1985, and 1995 traffic projections. Emission rates from motor vehicles were determined from the EPA publication Mobile Source Emission Factors and the accompanying MOBILE 1 Computer program. Projected traffic volumes, the associated vehicle miles of travel and the average travel speed were required in the computations.

Pollutant Loading (gm/day) = Average Daily Traffic (veh/day) x Length of Roadway (miles) x Emission Factor[8] (gm/mile)

EXISTING CONDITIONS

Basic data includes:

- Existing Site-Generated Traffic = 20,740 veh/day
- Length of Roadway - Airport drive from Cooperstown Expressway to Airport Terminal = 2.5 miles
- Average Travel Speed = 45 mph
- Emission Factors - CO = 28.16 gm/mile

  HC = 3.38 gm/mile

  NO_x = 4.27 gm/mile

  SO_x = 0.23 gm/mile

  Part = 0.60 gm/mile

---

[8] Emission factors for CO, HC, NO_x from MOBILE 1. SO_x and Particulate emission factors from "Compilations of Air Pollutant Emission Factors" (AP-42) Table 3.1.1-1 (SO_x-0.23 gm/mile and Particulates-0.60 gm/mile).

$$CO: [(20{,}740 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (28.16 \frac{gm}{mile})] = 1{,}460{,}096 \frac{gm}{day} = 3{,}219 \frac{lbs}{day}$$

$$HC: [(20{,}740 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (3.38 \frac{gm}{mile})] = 175{,}253 \frac{gm}{day} = 386 \frac{lbs}{day}$$

$$NO_x: [(20{,}740 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (4.27 \frac{gm}{mile})] = 221{,}399 \frac{gm}{day} = 488 \frac{lbs}{day}$$

$$SO_x: [(20{,}740 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.23 \frac{gm}{mile})] = 11{,}925 \frac{gm}{day} = 26 \frac{lbs}{day}$$

$$Part: [(20{,}740 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.60 \frac{gm}{mile})] = 31{,}110 \frac{gm}{day} = 69 \frac{lbs}{day}$$

1985 CONDITIONS

Basic data includes:

- 1985 Site-Generated Traffic = 25,800 veh/day
- Length of Roadway - 2.5 miles
- Average Travel Speed = 45 mph
- Emission Factors - CO = 19.39 gm/mile

  HC = 1.91 gm/mile

  NO_x = 3.47 gm/mile

  SO_x = 0.23 gm/mile

  Part = 0.60 gm/mile

$$CO: [(25{,}800 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (19.39 \frac{gm}{mile})] = 1{,}250{,}655 \frac{gm}{day} = 2{,}757 \frac{lbs}{day}$$

$$HC: [(25{,}800 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (1.91 \frac{gm}{mile})] = 123{,}195 \frac{gm}{day} = 272 \frac{lbs}{day}$$

$$NO_x: [(25{,}800 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (3.47 \frac{gm}{mile})] = 223{,}815 \frac{gm}{day} = 493 \frac{lbs}{day}$$

SO_x: $[(25{,}800 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.23 \frac{gm}{mile})] = 14{,}835 \frac{gm}{day} = 33 \frac{lbs}{day}$

Part: $[(25{,}800 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.47 \frac{gm}{mile})] = 30{,}315 \frac{gm}{day} = 67 \frac{lbs}{day}$

1995 CONDITIONS

Basic data includes:

- 1995 Site-Generated Traffic = 43,000 veh/day
- Length of Roadway - 2.5 miles
- Average Travel Speed = 40 mph
- Emission Factors - CO = 12.00 gm/mile
  - HC = 1.14 gm/mile
  - NO_x = 2.44 gm/mile
  - SO_x = 0.23 gm/mile
  - Part = 0.60 gm/mile

CO: $[(43{,}000 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (12.00 \frac{gm}{mile})] = 1{,}290{,}000 \frac{gm}{day} = 2{,}844 \frac{lbs}{day}$

HC: $[(43{,}000 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (1.14 \frac{gm}{mile})] = 122{,}550 \frac{gm}{day} = 270 \frac{lbs}{day}$

NO_x: $[(43{,}000 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (2.44 \frac{gm}{mile})] = 262{,}300 \frac{gm}{day} = 578 \frac{lbs}{day}$

SO_x: $[(43{,}000 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.23 \frac{gm}{mile})] = 24{,}725 \frac{gm}{day} = 55 \frac{lbs}{day}$

Part: $[(43{,}000 \frac{veh}{day}) \times (2.5 \text{ miles}) \times (0.60 \frac{gm}{mile})] = 64{,}500 \frac{gm}{day} = 142 \frac{lbs}{day}$

At large metropolitan airports, one major source that is included in the emission inventory is the service vehicle emissions. The following computations for aircraft service vehicle emissions are based on the methodologies given in EPA publication APTD-1470 (see Section I for reference).

Pollutant Loading (lb/day) = Service Time (veh-min/aircraft) x
Aircraft Volume (LTO/day) x
1 hr/60 min x
Fuel Consumption (gal/hr) x
Emission Rate (lb/gal)

First, vehicle-hours/day for each service vehicle type is computed (Table IV-2) using Table IV-1. Using the daily service vehicle fuel consumption rates (Table IV-3) and Table IV-2, daily fuel consumption was computed as shown in Table IV-4. Table IV-5, ground service vehicle uncontrolled emission factors (gasoline fueled), is used with Table IV-4 to compute the total daily pollutant loadings.

Table IV-1

Service Times of Aircraft Ground Service Vehicles

Vehicle \ Aircraft	Time in Vehicle-Minutes										
	B-747[a]	DC-10[a]	B-707[a]	DC-8[a]	B-727[a]	DC-9[a]	B-737[a]	C-880[a]	F-227[a]	C-580[a]	General Aviation [b]
Tractor	155	148	66	98	66	48	85	40	55	50	30
Belt Loader	48	40	37	30	28	15	30	40	0	25	0
Container Loader	92	80	12	0	6	0	0	0	0	0	0
Cabin Service	24	25	12	15	12	0	15	0	0	0	0
Lavatory Truck	24	18	15	18	15	15	15	20	10	10	10
Water Truck	12	10	0	0	0	10	0	0	10	10	10
Food Truck	55	20	20	30	17	17	20	20	10	10	10
Fuel Truck	50	45	37	40	20	15	15	20	10	20	10
Tow Tractor	10	10	10	5	10	5	5	15	5	5	5
Conditioner	0	0	30	30	0	0	0	0	0	0	0
Airstart	3	0	10	5	0	0	0	15	0	0	0
Diesel Power Unit	2	0	8	4	0	0	0	11	0	0	0
Ground Power Unit	0	0	9	0	0	0	0	35	0	0	0
Gasoline Power Unit	0	0	4	0	0	0	0	15	0	0	0
Diesel Power Unit	0	0	4	0	0	0	0	15	0	0	0
Transporter	19	0	10	0	3	0	0	0	0	0	0

[a] Source: "An Air Pollution Impact Methodology for Airports - Phase I" (APTD-1470) J. E. Norco, R. R. Cirillo, T. E. Baldwin and J. W. Gudenas, 1973. Table 3.12.

[b] Computed by Greiner Engineering Sciences, Inc.

Table IV-2
Ground Service Operating Time
(Vehicles-Hour/Day)

Vehicles	Aircraft	727	DC-9	Business Jet[a]	Turbo-prop[b]	Twin-Engine Piston	Total
Tractor	- Existing	37.40	15.20	----	2.75	64.00	119.35
	1985	46.20	24.00	----	4.58	78.50	153.28
	1995	68.20	38.40	----	8.25	110.00	224.85
Belt Loader	- Existing	15.87	4.75	----	----	------	20.62
	1985	19.60	7.50	----	----	------	27.10
	1995	28.93	12.00	----	----	------	40.93
Container Loader	- Existing	3.40	-----	----	----	------	3.40
	1985	4.20	-----	----	----	------	4.20
	1995	6.20	-----	----	----	------	6.20
Cabin Service	- Existing	6.80	-----	----	----	------	6.80
	1985	8.40	-----	----	----	------	8.40
	1995	12.40	-----	----	----	------	12.40
Lavatory Truck	- Existing	8.50	4.75	0.67	0.50	21.33	35.75
	1985	10.50	7.50	1.17	0.83	26.17	46.17
	1995	15.50	12.00	1.83	1.50	36.67	66.84
Water Truck	- Existing	-----	3.17	----	0.50	21.33	25.00
	1985	-----	5.00	----	0.83	26.17	32.00
	1995	-----	8.00	----	1.50	36.67	46.17
Food Truck	- Existing	9.63	5.38	----	0.50	21.33	36.84
	1985	11.90	8.50	----	0.83	26.17	47.40
	1995	17.57	13.60	----	1.50	36.67	69.34
Fuel Truck	- Existing	11.33	4.75	0.67	0.50	21.33	38.58
	1985	14.00	7.50	1.17	0.83	26.17	49.67
	1995	20.67	12.00	1.83	1.50	36.67	72.01
Tow Tractor	- Existing	5.67	1.58	0.33	0.25	10.67	18.50
	1985	7.00	2.50	0.58	0.42	13.08	23.58
	1995	10.33	4.00	0.92	0.75	18.33	33.99

[a] General Aviation service times used.
[b] F-227 service times used.

Table IV-3
Ground Service Vehicles
Fuel Consumption Rates

Vehicle	Rate of Fuel Consumption (gal/hr)
Tractor	1.80
Belt Loader	0.70
Container Loader	1.75
Cabin Service	1.50*
Lavatory Service	1.50*
Water Truck	1.50*
Food Truck	2.00*
Fuel Truck	1.70*
Tow Tractor	2.35
Conditioner	1.75
Airstart	
Transporting Engine	1.40
Diesel Power Unit	8.20
Ground Power Unit	
Transporting Engine	2.00
Gasoline Power Unit	5.00
Diesel Power Unit	7.10
Transporter	1.50

* Estimated Values

Source: "An Air Pollution Impact Methodology for Airports - Phase I" (APTD-1470) J. E. Norco, R. R. Cirillo, T. E. Baldwin and J. W. Gudenas, 1973. Table 3.37.

Table IV-4
Daily Fuel Consumption for Service Vehicles
(gal/day)

	Existing	1985	1995
Tractor	214.83	275.90	404.73
Belt Loader	14.43	18.97	28.65
Container Loader	5.95	7.35	10.85
Cabin Service	10.20	12.60	18.60
Lavatory Service	53.62	69.25	100.26
Water Truck	37.50	48.00	69.25
Food Truck	73.68	94.80	138.68
Fuel Truck	65.59	84.44	122.42
Tow Tractor	43.47	55.41	79.88
TOTAL	519.27	666.72	973.32

PAGES IV-30, IV31 ARE MISSING IN ORIGINAL DOCUMENT

The summary of the emission inventory data is presented in the following tables.

Existing Airport Emission Inventory (lb/day)

	CO	HC	NO_x	SO_x	Particulates
Aircraft Traffic	5,445	402	1,265	114	70
Vehicular Traffic[9]	3,219	386	488	26	69
Service Vehicles	1,144	255	65	1	2
Total	9,808	1,043	1,818	141	141

1985 Airport Emission Inventory (lb/day)

	CO	HC	NO_x	SO_x	Particulates
Aircraft Traffic	7,310	637	1,717	164	59
Vehicular Traffic[9]	2,757	272	493	33	67
Service Vehicles	1,468	328	84	1	3
Total	11,535	1,237	2,294	198	129

[9] Includes passenger, visitor, and employee traffic.

1995 Airport Emission Inventory (lb/day)					
	CO	HC	NO_x	SO_x	Particulates
Aircraft Traffic	11,058	1,083	2,641	270	90
Vehicular Traffic[10]	2,844	270	578	55	142
Service Vehicles	2,144	479	122	2	4
Total	16,046	1,832	3,341	426	236

Block 1-9 - With the completion of the emission inventory, a coordination meeting was scheduled with the State Air Quality Review Board. The State Review Board determined that the project is in conformance with the SIP. The Board also determined that the project level of airport activity would have the potential to cause violations of carbon monoxide standards.

Block 1-11 - The PAL computer model was selected to perform the dispersion analysis. This model was selected because it can compute simultaneously the dispersion impact from line, area and point sources. This model was also chosen because its input parameters are easy to understand and obtain. A more detailed discussion of the PAL model is contained in Section III.

10 Includes passenger, visitor, and employee traffic.

The input parameters used for the PAL dispersion model were:

Area Sources - Parking Lots

Existing - One Lot:

Width - 290 m
Length - 274 m
Strength - $17.59 \dfrac{gm}{min} \times \dfrac{1 \text{ min}}{60 \text{ sec}} \times \dfrac{1}{290 \times 274 \text{ m}^2}$

$$= 3.7 \times 10^{-6} \frac{gm}{m^2\text{-sec}} \quad CO$$

1985 - Expansion of Existing Lot:

Width - 330 m
Length - 274 m
Strength - $10.24 \dfrac{gm}{min} \times \dfrac{1 \text{ min}}{60 \text{ sec}} \times \dfrac{1}{330 \times 274 \text{ m}^2}$

$$= 1.9 \times 10^{-6} \frac{gm}{m^2\text{-sec}} \quad CO$$

1995 - Existing Lot with Two New Lots:

Old Lot - Width - 330 m
Length - 274 m
Strength - $5.55 \dfrac{gm}{min} \times \dfrac{1 \text{ min}}{60 \text{ sec}} \times \dfrac{1}{330 \times 274 \text{ m}^2}$

$$= 1.02 \times 10^{-6} \frac{gm}{m^2\text{-sec}} \quad CO$$

New Lot - North of Airport Drive

Width - 274 m
Length - 192 m
Strength - $5.55 \dfrac{gm}{min} \times \dfrac{1 \text{ min}}{60 \text{ sec}} \times \dfrac{1}{274 \times 192 \text{ m}^2}$

$$= 1.8 \times 10^{-6} \frac{gm}{m^2\text{-sec}} \quad CO$$

New Lot - South of Airport Drive

Width - 274 m
Length - 165 m
Strength - $5.55 \frac{gm}{min} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1}{274 \times 165 m^2}$

$$= 2.1 \times 10^{-6} \frac{gm}{m^2\text{-sec}} \quad CO$$

Line Source - Roadways

Airport Drive - 4 lanes

Total Roadway Width - 36 m
Median Width - 15 m
Existing Speed - 45 mph
Volume - 2,904 veh/hr
Strength:

$$q = 1.726 \times 10^{-7} \times EF \text{ (gm/mile)} \times TV \text{ (veh/hr)}$$

$$= 1.726 \times 10^{-7} \times 28.16 \times 2{,}904$$

$$= .0141 \text{ gm/sec-m} \quad CO$$

1985 Speed - 45 mph
Volume - 3,612 veh/hr
Strength:

$$q = 1.726 \times 10^{-7} \times 19.39 \text{ (gm/mile)} \times 3{,}612 \text{ (veh/hr)}$$

$$= .0121 \text{ gm/sec-m} \quad CO$$

1995 Speed - 40 mph
Volume - 6,020 veh/hr
Strength:

$$q = 1.726 \times 10^{-7} \times 12.0 \text{ (gm/mile)} \times 6{,}020 \text{ (veh/hr)}$$

$$= .0125 \text{ gm/sec-m} \quad CO$$

Line Source - Runway

(Determined from Peak-Hour Operations)

Existing Operations: 25 ops/hr

1985: 32 ops/hr

1995: 46 ops/hr

Runway Emission Density

727:	(6.99 + 7.91)[11] lb/hr-eng x 3 eng	=	44.7 lbs/hr
DC-9:	(6.99 + 7.9) lb/hr-eng x 2 eng	=	29.8 lbs/hr
Business Jet:	(75.06 + 65.61) lb/hr-eng x 2 eng	=	281.3 lbs/hr
Turboprop:	(0.43 + 0.48) lb/hr-eng x 2 eng	=	1.8 lbs/hr
Twin-Engine Piston:	(143.9 + 95.6) lb/hr-eng x 2 eng	=	479.0 lbs/hr
			836.6 lbs/hr

Density is equal to:

$$836.6 \text{ lb/hr} \times \frac{1 \text{ hr}}{3{,}600 \text{ sec}} \times 454 \text{ gm/lb} = 105.4 \text{ gm/sec CO}$$

Five receptor points were chosen (see Figure IV-2) and various wind directions were used to disperse the pollutant emissions to the receptor points. Using the PAL computer program, the results of the dispersion study are shown on the following tables.

11 Take-Off and Climbout mode emission factors from AP-42.

Existing CO Concentrations
mg/m^3

Source	Receptor Points									
	1		2		3		4		5	
	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour
Parking Lot				0.03	0.09	0.04	0.11	0.03		
Roadway		0.09		0.31		0.97		0.12	0.64	0.08
Runway	6.01	0.75	2.34	0.53	3.79	0.51	2.04	0.29	1.11	0.14
Total	6.01	0.84	2.34	0.87	3.88	1.52	2.15	0.44	1.75	0.22
Background	5.25	3.15	5.25	3.15	5.25	3.15	5.25	3.15	5.25	3.15
Total	11.26	3.99	7.59	4.02	9.13	4.67	7.40	3.59	7.00	3.37

1985 CO Concentrations
mg/m^3

Source	Receptor Points									
	1		[illegible]		3		4		5	
	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour
Parking Lot				0.02	0.05	0.02		0.01		
Roadway		0.07	1.96	0.26	3.25	0.83		0.11		0.68
Runway	3.12	0.50		0.60	3.30	0.65	1.39	0.54	7.19	0.97
Total	3.12	0.57	1.96	0.88	6.60	1.50	1.39	0.66	7.19	1.65
Background	4.13	2.68	4.13	2.68	4.13	2.68	4.13	2.68	4.13	2.68
Total	7.25	3.25	6.09	3.56	10.73	4.18	5.52	3.34	11.32	4.33

1995 CO Concentrations
mg/m^3

Source	Receptor Points									
	1		2		3		4		5	
	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour
Parking Lot			0.03	0.02	0.04	0.02		0.02		
Roadway		0.08		0.28	3.36	0.86		0.11		0.07
Runway	4.33	0.71	2.26	0.86		0.93	2.58	0.79	10.60	1.42
Total	4.33	0.79	2.29	1.16	3.40	1.81	2.58	0.92	10.60	1.49
Background	3.65	2.06	3.65	2.06	3.65	2.06	3.65	2.06	3.65	2.06
Total	7.98	2.85	5.94	3.22	7.05	3.87	6.23	2.98	14.25	3.55

The resulting concentrations were compared to the Carbon Monoxide 1-hour and 8-hour National Ambient Air Quality Standards (NAAQS). The 1-hour standard is 40 mg/m^3 while the 8-hour standard is 10 mg/m^3. Comparing the dispersion results to the NAAQS standards, no violations were found to occur at any receptor point or for any of the study years (Block 1-12). This completed the dispersion analysis of the project.

Block 1-14 - The study results were assembled and summarized. A formalized air quality report was written and an Air Quality Certification was obtained (Block 1-16). The air quality report was made a part of the Environmental Assessment for the airport expansion and circulated (Block 1-17).

SCENARIO 3 - UNIT CONVERSION

The United States Air Force (USAF) is proposing to relocate a unit of F-15 fighter aircraft to replace the 18 OA-37B aircraft assigned to the Clear Springs Air Force Base (Figure IV-3). On a typical day an F-15 assigned to this base is scheduled to fly a Military Training Route (MTR), conduct aerial refueling and operate in a Military Operating Area (MOA) or over a range. The F-15's would spend almost half of their time in weapons delivery and associated aerial tactics on or near a bombing/gunnery range, with the remainder devoted to navigation and refueling.

Block 2-1 - The first step is to complete Form 813 (Request for Environmental Impact Analysis) and decide the type of analysis that is needed. A unit conversion is not included under the Category Exclusion section of AFR 19-2.

Blocks 2-3 - Next, the Preliminary Environmental Survey Form 814 is filled out. The completion of this form shows that the air quality effects of this project are unknown and further investigation is needed.

Block 2-5 - Data collection was undertaken to determine existing air quality and a review of the State SIP was performed.

Block 2-6 - By reviewing existing air quality regulations, it was learned that the state does not have any Indirect Source Review.

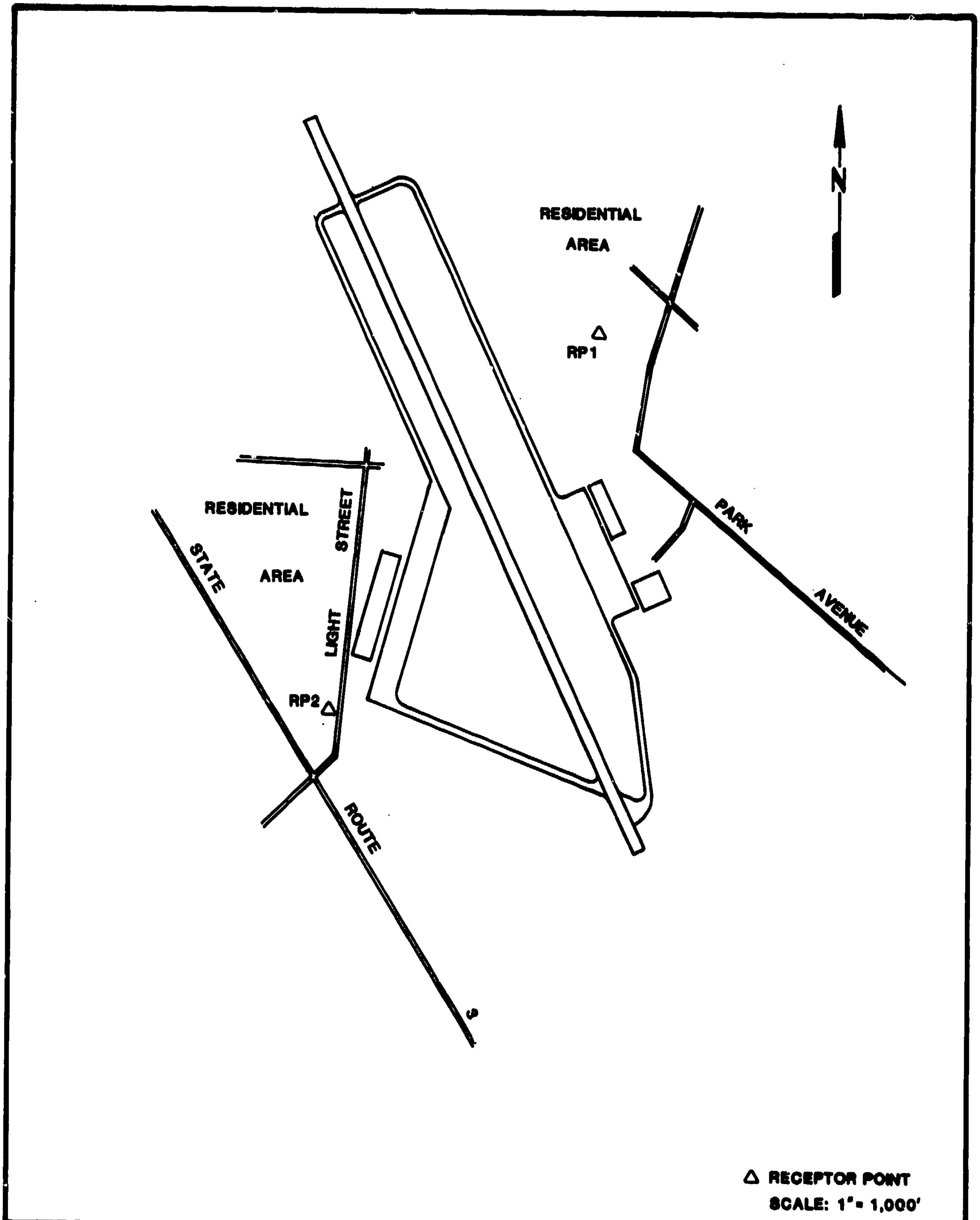
Block 2-9 - Using the available operational data, an emission inventory of F-15 and OA-37B yearly operations was conducted. F-15 emissions are based on an anticipated four sorties during a peak-hour and an average of ten sorties per day, six days per week. A sortie is equal to one landing and one takeoff. OA-37B data is based on four sorties for a peak-hour and ten sorties per day, six days per week.

In order to obtain the yearly pollution total (metric tons) for each pollutant for each aircraft type, the emission factor per landing-takeoff cycle (LTO) is multiplied by the total number of LTO's per day times the number of days of operation. The aircraft emission factors are taken from the ACEE report (CEEDO-TR-78-33).

F-15

CO: 10 LTO/day $\times$ 1.27 $\times 10^{-2}$ MT/LTO $\times$ 312 day/year = 39.62 MT/year

HC: 10 LTO/day $\times$ 1.56 $\times 10^{-3}$ MT/LTO $\times$ 312 day/year = 4.87 MT/year



BASIC LAYOUT PLAN
AIR QUALITY ANALYSIS

Figure IV-3

NO_x: 10 LTO/day x 3.50 x 10^{-3} MT/LTO x 312 day/year = 10.92 MT/year

SO_x: 10 LTO/day x 8.93 x 10^{-4} MT/LTO x 312 day/year = 2.79 MT/year

Part.: 10 LTO/day x 1.30 x 10^{-4} MT/LTO x 312 day/year = 0.41 MT/year

<u>OA-37B</u>

CO: 10 LTO/day x 4.55 x 10^{-2} MT/LTO x 312 day/year = 141.96 MT/year

HC: 10 LTO/day x 7.01 x 10^{-3} MT/LTO x 312 day/year = 21.87 MT/year

NO_x: 10 LTO/day x 6.98 x 10^{-4} MT/LTO x 312 day/year = 2.18 MT/year

SO_x: 10 LTO/day x 3.87 x 10^{-4} MT/LTO x 312 day/year = 1.21 MT/year

Part.: 10 LTO/day x 3.24 x 10^{-6} MT/LTO x 312 day/year = 1.01 x 10^{-2} MT/year

When the existing environment with OA-37B is compared to the proposed environment with the F-15, the following differences in pollutants emitted are identified.

CO: -102.34 MT/year

HC: -17.00 MT/year

NO_x: +8.74 MT/year

SO_x: +1.58 MT/year

Part: +.40 MT/year

There will be a net reduction in CO and HC annual emissions. Emissions of NO_x, Particulate Matter and SO_x are expected to increase. An increase of 9 metric tons per year of NO_x is not expected to generate a problem in the airport area.

<u>Block 2-10</u> - A consultation meeting was held with the State Air Quality Review Agency. When the SIP was reviewed to determine action consistency, it was learned that the project was in a designated CO non-attainment area. In order to ascertain the impact of the project on CO ambient levels, a dispersion analysis was required (Block 2-12).

In order to further quantify the effect of aircraft air pollutant emission in the project area, the PAL computer model was selected to perform the dispersion analysis (Block 2-12). This model was chosen because its input parameters are easy to understand and obtain.

The input parameters used for the PAL dispersion model were:

Runway Emission Density

F-15

$$CO: 1.27 \times 10^{-2} \text{ MT/LTO} \times 4 \text{ LTO/hour} = 5.08 \times 10^{-2} \text{ MT/hour}$$

$$5.08 \times 10^{-2} \text{ MT/hour} \times \frac{1 \text{ hour}}{3600 \text{ seconds}} \times 10^{6} \text{ gm/MT}$$

$$= 14.11 \text{ gm/sec}$$

Two receptor points were located in the closest residential areas to the airport. Worst case meteorology was used to disperse the pollutant emissions to the receptor ponts.

Dispersion from roadways was not analyzed because there will not be any changes in vehicular traffic caused by the unit conversion. Some personnel may be added but others will be transferred. The unit conversion will not result in a net gain of personnel to the base.

Using the PAL computer program, the results of the dispersion study are shown in the following table.

CO Concentrations mg/m^3			
Receptor Point 1		Receptor Point 2	
1 Hour	8 Hours	1 Hour	8 Hours
0.044	0.029	0.034	0.0221

These concentrations are well below the National Ambient Air Quality Standards for one and eight hours (Block 2-13).

Block 2-15 - The study results were assembled and summarized for inclusion within the project's Environmental Assessment.

Block 2-16 - Based on the findings of the Environmental Assessment, Form 815 "Environmental Assessment Certificate" was filled out. The Air Quality Analysis results indicate small or no impact to the air quality from this project. If there are no other environmental impacts, then a statement of Findings of No Significant Impact (FONSI) can be issued and the analysis is complete (Block 2-18).

SCENARIO 4 - LOW LEVEL FLIGHTS

The Unites States Air Force is proposing to establish a Military Operating Area (MOA) in the Southwest section of the country. This particular MOA is planned to allow random, low-level operations by A-10 ground support fighter aircraft. These flights would be below 10,000 feet Mean Sea Level (MSL) and at speeds exceeding 250 knots indicated airspeed (KIAS).

Block 2-1 - Form 813 (Request for Environmental Impact Analysis) is completed and a determination made of the type of analysis that is required. This project is not covered by a Categorical Exclusion (CATEX) and it was decided an Environmental Assessment is required.

Block 2-3 - Form 814 "Preliminary Environmental Survey" is filled out. The project is expected to produce air quality impacts but it cannot be determined at this stage what the effect of these impacts will be.

Block 2-5 - Existing air quality data is collected and a review made of the State Implementation Plan (SIP). From the SIP it was determined that the project is not located in a pollutant nonattainment area. The project is not located in a state with Indirect Source Review (Block 2-6).

Block 2-9 - Military aircraft conducting flight training operations within the MOA will emit air pollution contaminants of particulates, hydrocarbons, carbon monoxide and oxides of sulfur and nitrogen. The quantity of each pollutant was derived by using data for A-10 aircraft pollutant emission rates and the projected annual hours of flying activity in the MOA.

The aircraft emission inventory was computed using the modal emission factors and fuel flow from the ACEE report times the hours of flying activity. The emission factor will be based on using military thrust throughout the MOA. The emission factor for the A-10 is the emission rate times the fuel flow.

CO: 2.3 g/kg-fuel/engine x .323 kg/s x 2 engines = 1.486 g/sec

HC: 0.1 g/kg-fuel/engine x .323 kg/s x 2 engines = 0.646 g/sec

NO_x: 10 g/kg-fuel/engine x .323 kg/s x 2 engines = 6.46 g/sec

Part: 0.05 g/kg-fuel/engine x .323 kg/s x 2 engines = 0.0322 g/sec

It was estimated that the A-10's will fly approximately 2,000 hours per year.

CO: 1.486 g/sec x 3600 sec/hour x 2000 hours/year x 10^{-6} MT/gm

= 10.70 MT/year

HC: 0.0646 g/sec x 3600 sec/hour x 2000 hours/year x 10^{-6} MT/gm

= 0.46 MT/year

NOx: 6.46 g/sec x 3600 sec/hour x 2000 hours/year x 10^{-6} MT/gm

= 46.52 MT/year

Part: 0.0322 g/sec x 3600 sec/hour x 2000 hours/year x 10^{-6} MT/gm

= 0.24 MT/year

The aircraft's total emissions are a small percentage of the total emissions in the MOA and are not significant in terms of regional air quality.

Block 2-10 - A meeting was held with the State Air Quality Review Agency to determine action conformity with the SIP. The project was determined to be consistent with the SIP. Because of the type of action being proposed (low level flights at high speeds), the State Review Board did request that a dispersion study be performed to determine ground level CO concentrations.

Block 2-12 - The U.S. Environmental Protection Agency's Point Area Line (PAL) model was used to evaluate the pollution concentrations of aircraft operating in the MOA areas. Aircraft emission factors were obtained from the ACEE report. The carbon monoxide concentration were predicted for a 2.0 kilometer flight track at 200 meters per second ground speed and 90 meters above ground level.

The CO emission factor from the ACEE report is:

2.3 g/kg fuel/engine x .323 kg/s x 2 engines = 1.486 g/sec

Four receptor points were chosen, two under the aircraft flight path and two downwind of the the flight path. The predicted worse case ground level one hour CO pollutant concentrations are listed in the following table.

CO Concentrations

mg/m^3

	Receptor Point 1		Receptor Point 2	
	1 Hour	8 Hours	1 Hour	8 Hours
	0.25×10^{-4}	0.16×10^{-4}	0.24×10^{-4}	0.16×10^{-4}
	Receptor Point 3		**Receptor Point 4**	
	1 Hour	8 Hours	1 Hour	8 Hours
	0.11×10^{-4}	0.71×10^{-5}	0.41×10^{-6}	0.27×10^{-6}

Block 2-13 - The PAL results indicated an insignificant air quality impact should this proposal be implemented. The study results were then assembled and documented for inclusion within the Assessment Report (Block 2-15).

Block 2-16 - Form 815 "Environmental Assessment Certificate" incorporating the results of the Environmental Assessment was completed. The air quality analysis indicatd that there would be no significant impact to the MOA area by the proposed project. If there are no other environmental parameters to be analyzed, then a statement of Findings of No Significant Impact (FONSI) can be issued to complete the project analysis (Block 2-18).

SECTION V

SECTION V: GLOSSARY AND ANNOTATED REFERENCE LIST

GLOSSARY

In order to assist in the understanding of the other sections of this handbook, a glossary of basic air quality terms has been added.

A

Air Quality Data Base

A collection of information about ambient air quality that existed within an area during a particular time period. This data is usually collected and published by the State Air Pollution Control Agency.

Air Quality Model

An algorithmic relationship between pollutant emissions and pollutant concentrations used in the prediction of a project's pollutant impact.

Air Quality Monitor

A device for measuring pollutant concentrations. One such device is a Non-Dispersed Infrared Analyzer used to record carbon monoxide concentrations.

Air Quality Standard

A legal requirement for air quality, usually expressed in terms of a maximum allowable pollutant concentration averaged over a specified interval. For example, the one-hour national standard for carbon monoxide is 40 mg/m^3.

Ambient Concentrations

Initial concentration sensed/measured at a monitoring/sampling site.

A—Continued

Ambient Monitoring

Systematic measurements of the characteristics (e.g., pollutant concentration and wind velocity) of the air at a fixed location.

Air Quality Control Region (AQCR)

An interstate or intrastate geographic region designated by the EPA that has significant air pollution or the potential for significant air pollution and, due to topography, meteorology, etc., needs a common air quality control strategy. The region includes all the counties that are affected by or have sources that contribute directly to the air quality of that region.

Area Source

The agglomeration of many sources that have low emission rates spread over a large area which are too numerous to treat individually. An example of this type of source would be a parking lot.

Atmospheric Stability

The resistance to or enhancement of vertical air movement related to the vertical temperature profile (see Pasquill Stability Classification).

Averaging Time

A period over which measurements of air quality parameters are taken. Air quality standards are specified for averaging times of one, three, eight and twenty-four hours, as well as one year.

B

Background Concentration

Pollutant concentration due to natural sources and distant unidentified man-made sources.

C

Carbon Monoxide (CO)

This is a colorless, odorless, toxic gas produced by the incomplete burning of the carbon in fossil fuels.

Clean Air Act

The Federal law regulating air quality; when amended in 1967, it required that air quality criteria necessary to protect the public health and welfare be developed.

Clean Air Act Amendments

The 1970 Amendments to the Clean Air Act redefined the strategy of the Act and called for every state to submit an implementation plan to the EPA describing the control strategies to be used to attain compliance with National Ambient Air Quality Standards.

The 1977 Amendments called for each state to revise its implementation plan in order to provide for the attainment of the National Ambient Air Quality Standards as expeditiously as practicable but not later than December 31, 1982 (December 31, 1987 under certain conditions for photochemical oxidants and/or carbon monoxide). It also called for the states to protect areas where the air was still relatively clean.

Control Strategy

A combination of limiting measures designed to achieve the aggregate reduction of emissions. For example, a State Implementation Plan may contain a Transportation Control Plan with strategies to reduce vehicular miles traveled and an Inspection and Maintenance Program.

Criteria Pollutant

A pollutant for which EPA has established a National Ambient Air Quality Standard, i.e., oxidants, NO_2, SO_2, CO, HC, TSP, and Pb.

D

Diffusion

The gradual mixing of the molecules of two or more pollutants as a result of random thermal motion.

Dispersion

The process by which atmospheric pollutants disseminate due to wind and vertical stability.

Driving Cycle

A profile of velocity versus time, specified for determining vehicular emission rates. This cycle would include periods of stopping, acceleration, cruising and deceleration.

E

Emission Factor

The rate at which pollutants are emitted into the atmosphere by one source or a combination of sources.

Emission Inventory

A complete list of sources and rates of pollutant emissions within a specified area and time interval.

Environmental Impact Statement

A Federal document in which the impacts of any major Federal action which may have a significant environmental effect are evaluated prior to its construction or implementation, as required by the National Environmental Policy Act of 1969, As Amended.

EPA

U.S. Environmental Protection Agency.

F

Frequency Distribution

A curve of the percentage frequency of occurrence of each value that a variable may take on.

G

Gaussian Model

A pollutant dispersion model based on the Gaussian dispersion equation, which assumes a constant fractional decrease in concentration per unit distance in the crosswind and vertical direction from a stationary or moving center of dispersion.

H

Hydrocarbons (HC)

These gases represent unburned and wasted fuel. They come from incomplete combustion of gasoline and from evaporation of petroleum fuels.

I

IAS

Indicated air speed.

Indirect Control

Control of air quality by altering activities that influence the rate and distribution of emissions (e.g., traffic patterns, land use). Indirect control contrasts with direct control at the source of the emissions (e.g., devices on automobiles or smoke stacks).

Indirect Source

Any structure or installation which attracts an activity which creates emissions of pollutants. For example, a shopping center, an airport, or a stadium can all be considered to be indirect sources.

I—Continued

IFR (Instrument Flight Rules)

Weather conditions below the minimum for flight under visual flight rules.

IFR Military Training Routes

Routes used by the Department of Defense and the associated Reserve and Air Guard units for the purpose of conducting low-altitude navigation and tactical training in both the IFR and VFR weather conditions below 10,000 feet MSL at air speeds in excess of 250 knots IAS.

Inventory

See "Emission Inventory."

Inversion

A thermal gradient created by warm air situated above cooler air. An inversion suppresses turbulent mixing and thus limits the upward dispersion of polluted air.

L

Land Breeze

A light wind blowing from land to a large body of water at night due to temperature differences between land and water.

Lead

This is a heavy metal that when ingested or inhaled affects the blood forming organs, kidneys and the nervous system. The chief source of this pollutant is the combustion of leaded gasoline in automobiles.

Line Source

A long, narrow source of emissions such as a roadway or runway.

L—Continued

Link

A portion of a road in a highway network.

Local Meteorology

The weather conditions, temperature, wind velocity, mixing height, cloud cover, etc., that exist in a particular area.

Low Altitude Operations

Operations conducted below 18,000 feet MSL.

M

Macroscale

Large scale, involving distances of 100 to several thousand kilometers and times of one to several days.

MSL

Mean Sea Level.

Mesoscale

Medium or middle scale involving distances of 1 to 100 kilometers and times of one to twenty-four hours. An emission inventory for an airport would be done on a mesoscale basis.

Meteorological Variables

Wind speed and direction, mixing height, temperature, pressure, degree of turbulence, sunlight intensity, humidity, and precipitation.

M—Continued

Microscale

Small scale, involving distances up to approximately one kilometer and times up to a few tens of minutes. The computing of pollutant concentrations at receptor points is an example of a microscale analysis.

Military Operations Area

A MOA is an air space assignment of defined vertical and lateral dimensions established outside positive control area to separate/segregate certain military activities from IFR traffic and to identify for VFR traffic where these activities are conducted.

$\mu g/m^3$

Micrograms per cubic meter.

Mobile Source

A moving vehicle that emits pollutants. Such sources include airplanes, automobiles, trucks, trains, ships and farm equipment.

Modal Emission Factors

Vehicular emissions factors for individual modes of operation. For aircraft, these modes would include climbout, approach and taxiing.

Monitoring Site

The location of a measurement device in a monitoring network.

N

NAAQS

National Ambient Air Quality Standards, established by the EPA to protect human health (primary standards) and to protect property and aesthetics (secondary standards).

N—Continued

Nitrogen Oxides (NO_x)

A poisonous and highly reactive gas produced when fuel is burned at high temperatures causing some of the abundant nitrogen in the air to burn also. This pollutant is emitted by automobile or aircraft engines, electric power plants, and other very large energy-conversion processes.

Nonattainment Area

A geographic area designated by EPA where violation of at least one National Ambient Air Quality Standard occurs.

O

Ozone (O_3)

This is a colorless, toxic gas formed by the photochemical reactions of hydrocarbons with the oxides of nitrogen.

P

Pasquill Stability Classification

A method of classifying atmospheric stability based on incoming solar radiation and wind speed. The stability classifications range from A stability (extremely unstable conditions) to F stability (moderately stable conditions).

Photochemical Smog

The atmospheric condition that results when hydrocarbons and nitrogen oxides emitted in the atmosphere react in the presence of sunlight to form other pollutants, such as oxidants.

P—Continued

Plume

The spreading pollutants emitted by a fixed source such as a smokestack.

Point Stationary Source

A pollutant source that is fixed to the ground and that releases pollutants through a relatively small area (e.g., a smokestack).

PPM

Parts per million (10^6) by volume.

Precursor

A chemical compound that leads to the formation of a pollutant. Hydrocarbons and nitrogen oxides are precursors of photochemical oxidants.

Prevention of Significant Deterioration (PSD) Area

A geographic area that contains air which is relatively clean and not in violation of the National Ambient Air Quality Standards. The emissions in these areas are regulated to prevent degradation of its air quality.

Primary Pollutant

Chemical contaminants which are released directly to the atmosphere by a source.

Primary Standard

A National Ambient Air Quality Standard set to protect human health.

R

Receptor Point

A designated location where pollutant levels are examined.

S

Sea Breeze

A light wind blowing from a large body of water to surrounding land areas during the day due to temperature differences between land and water.

Secondary Pollutant

Atmospheric contaminants formed in the atmosphere as a result of such chemical reactions, as hydrolysis, oxidation, and photochemistry.

Secondary Standard

A National Ambient Air Quality Standard set to protect human welfare.

Simulation Model

A mathematical description of a real physical and/or chemical process. The responses of the model to input parameter variations are analogous to those of the real processes.

Stability

A property of the atmosphere which determines the amount of vertical mixing.

Stable Layer

A layer of air in which very little mixing takes place.

State Implementation Plan

The strategy to be used by a state to control air pollution in order that the National Ambient Air Quality Standards will be met. EPA regulations require that each state devise such a plan or the EPA will impose its own plan for that state.

Stationary Source

A source of pollutants which is immobile. Such sources include industrial complexes, power plants, and individual heating units.

S—Continued

Sulfur Dioxide (SO_2)

This is a corrosive and poisonous gas produced mainly from the burning of sulfur containing fuel.

Surface Layer

The layer of air near the ground, generally 1 to 100 meters high, where surface features (e.g., trees, buildings) affect atmospheric turbulence and diffusion.

T

Total Suspended Particulates (TSP)

These are solid or liquid particles small enough to remain suspended in air. They range widely in size from particles visible as soot or smoke to those too small to detect except with an electron microscope.

Transportation Control Plan (TCP)

A plan specifying measures to regulate the emission of pollutants from mobile sources.

Turbulence

Unsteady and irregular motions of air in the atmosphere.

V

Vehicle Miles Traveled (VMT)

The sum of distances traveled by all motor vehicles in a specified region. This sum is used in computing an emission inventory for motor vehicles.

VFR

Flying using visual flight rules.

W

Wind Rose

A circular diagram showing the frequency of wind directions experienced at a given location over some period of time.

ANNOTATED REFERENCE LIST

Many useful technical air quality documents are available which explain the various methodologies and document relateu study results. These references are highlighted below:

1. U.S. Air Force Engineering and Service Center CEEDO, September 1978. Aircraft Air Pollution Emission Estimation and Techniques - ACEE, CEEDO-TR-78-33.

   This report presents a five-step analytical methodology that can be adapted to nearly any aircraft related air quality assessment problem. The methodology is for use by base level environmental personnel to calculate (1) annual aircraft emissions and (2) downfield pollutant concentrations.

2. U.S. Environmental Protection Agency. August 1978. User's Guide to MOBILE 1: Mobile Source Emissions Model, EPA Report No. EPA-400/9-78-007.

   This document presents a computer model that calculates composite emission factors for Hydrocarbons, Carbon Monoxide and Oxides of Nitrogen from motor vehicles.

3. U.S. Environmental Protection Agency. February 1981. User's Guide to MOBILE 2: Mobile Source Emissions Model, EPA Report No. EPA 46013-81.006.

   This document presents a computer model that calculates composite emission factors for Hydrocarbons, Carbon Monoxide and Oxides of Nitrogen from motor vehicles. MOBILE 2 supercedes MOBILE 1 and incorporates several new options, calculating methodologies, emission factor estimates, emission control regulations and program designs.

4. U.S. Environmental Protection Agency. July 1975. Handbook for the Review of Airport Environmental Impact Statements EPA Report ANLIES-46.

   This report supplies to airport planners and reviewing agencies guidelines for the technical review of airport environmental impact statements.

5. U.S. Environmental Protection Agency. May 1980. User's Guide for HIWAY 2 - A Highway Air Pollution Model EPA Report No. EPA-600/8-80-018.

This document describes a computer model HIWAY 2 that can be used to estimate the concentrations of nonreactive pollutants at receptor locations downwind of "at-grade" and "cut section" highways.

6. U.S. Environmental Protection Agency. 1972. Aircraft Emissions: Impact on Air Quality and Feasibility of Control.

This report presents the available information on the present and predicted nature and extent of aircraft air pollution in the United States. It also discusses the present and future technological feasibility of controlling such emissions.

7. U.S. Environmental Protection Agency. February 1978. User's Guide for PAL, A Gaussian-Plume Algorithm for Point, Area, and Line Sources. EPA Report EPA-600/4-78-013.

This report presents a method of estimating short-term dispersion concentrations using Gaussian-plume steady-state assumptions for point, area, and line sources.

8. U.S. Environmental Protection Agency. October 1978. Air Pollutant Emission Factors for Military and Civil Aircraft. EPA Report No. EPA-450/3-78-117.

This document provides aircraft engine emission factors for military and civilian aircraft.

9. U.S. Environmental Protection Agency. March 1977. Aircraft Emission Factors. EPA Report PB 275 067.

This report provides updated aircraft engine emission factors and a sample of the calculation methodology used in obtaining these numbers.

10. U.S. Environmental Protection Agency. December 1974. Airport Emission Inventory Methodology. EPA Report No. EPA-450/3-75-048.

This report describes a methodology for performing emission inventories at airports. Within the basic methodology, three sub-methodologies are presented corresponding to municipal, military, and civilian airports.

11. U.S. Environmental Protection Agency. January 1973. An Air Pollution Impact Methodology for Airports - Phase I. EPA Report APTD-1470.

This report presents a methodology for assessing the air pollution impact of major commercial airports and the urban activities that surround them.

12. U.S. Environmental Protection Agency. March 1973. Guide For Compiling A Comprehensive Emission Inventory. EPA Report APTD-1135.

This report describes the procedures for obtaining and codifying information about air pollutant emissions from stationary and mobile sources.

13. U.S. Environmental Protection Agency. January 1973. Workbook of Atmospheric Dispersion Estimates.

This workbook presents methods of practical application of the binormal continuous plume dispersion model to estimate concentrations of air pollutants. Estimates of dispersion are those of Pasquill as restated by Gifford with emphasis on estimating concentrations from continuous sources.

14. U.S. Environmental Protection Agency. February 1976. Compilation of Air Pollutant Emission Factors. Second Edition with Supplements. EPA Report AP-42.

This document presents data available on those atmospheric emissions for which sufficient information exists to establish realistic emission factors. These emission factors cover most of the common emission categories: fuel combustion by stationary and mobile sources; combustion of solid waste; evaporation of fuels, solvents, and other volatile substances; various industrial processes; and miscellaneous sources. This is one of the most utilized references in airport pollution analyses.

15. U.S. Environmental Protection Agency. September 1980. Guidelines for Air Quality Maintenance Planning and Analysis. Volumes 1 through 14. EPA Report No. EPA-450/4-78-001.

This series of documents provide State and local agencies with information and guidance for the preparation of Air Quality Maintenance Plans.

16. U.S. Environmental Protection Agency. 1978. Carbon Monoxide Hotspot Guidelines, Volumes 1-6. EPA Report Nos. EPA-450/3-78-033, 034, 035, 036, 037, 040.

These documents present techniques and guidelines for locating and analyzing potential carbon monoxide hotspot near roadways and intersections.

17. Federal Aviation Administration. December 1975. Airport Vicinity Pollution Model User Guide. FAA Report No. FAA-RD-75-230.

This report describes the computer code and input methodology of the Airport Vicinity Air Pollution (AVAP) model. Samples of input and output are presented as well as the basic formulas used in the calculations.

18. Federal Aviation Administration. July 1980. Impact of Aircraft Emissions on Air Quality in the Vicinity of Airports, and Sub-Model Development. FAA Report No. FAA-EE-80-09A.

This report, the first of two volumes, documents the results of a combined FAA/EPA study to assess the impact of CO, HC, and NO_x in the vicinity of airports. Volume I covers the information gathered during a series of monitoring programs at Washington National, Los Angeles International, Dulles International, and Lakeland, Florida airports.

19. Federal Aviation Administration. July 1980. Impact of Aircraft Emissions on Air Quality in the Vicinity of Airports, Volume II: An updated Model Assessment of Aircraft Generated Air Pollution at LAX, JFK, and ORD. FAA Report No. FAA-EE-80-09B.

This document presents the second part of a two-volume combined FAA/EPA study. The report attempts to realistically simulate the air quality impact of aircraft in and around airport property during adverse dispersion conditions.

20. Federal Aviation Administration. June 1981. Environmental Handbook, Draft FAA Order 1050.15.

This order provides guidance and instructions necessary for preparing and processing the environmental assessments of Federal Aviation Administration actions.

21. Federal Aviation Administration. March 1980. Airport Environmental Handbook, FAA Order 5050.4.

This order provides instructions and guidance for preparing and processing the environmental assessments of airport development proposals and other airport actions as required by various laws and regulations.

22. Federal Aviation Administration, July 1981. SIMPLEX "A" - A Simplified Atmospheric Dispersion Model For Airport Use (Users Guide). FAA Report No. FAA-EE-81-8.

This document describes the method, limitations and uses of the SIMPLEX "A" atmospheric dispersion model. This model determines pollutant concentrations from taking-off aircraft and has the flexibility to easily accept parameter changes. It can treat either single or multiple aircraft departures and permits air quality calculations to be made by persons without an extensive computer background.

23. Federal Highway Administration. November 1979. CALINE 3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA Report No. FHWA/CA/TL-79123.

This report describes a model that can be used to predict carbon monoxide concentrations near highways and arterial streets given traffic emissions, site geometry and meteorology.

24. Federal Highway Administration. June 1978. Highway Air Quality Impact Appraisals, Volume II Guidance for Highway Planners and Engineers. FHWA Report No. FHWA-RD-78-100.

This document provides guidance for highway planners and engineers in selecting and designing air quality analyses that should be performed as part of a transportation planning project.

25. Schewe, George J., Laurence J. Budney, and Bruce C. Jordan. October 16-18, 1978. CO Impact of General Aviation Aircraft. Paper presented at the Air Quality and Aviation: An International Conference.

This paper presents a modeling analysis of the impact of general aviation aircraft on ambient carbon monoxide concentrations.

26. Segal, H.M., Yamartino, R. The Influence of Aircraft Operations on Air Quality at Airports. Journal of the Air Pollution Control Association, August 1981.

This paper presents the results of a FAA/EPA study which includes the assessment of air quality at five commercial and one general aviation airport.

TECHNICAL APPENDIX

AIRCRAFT ACTIVITY THRESHOLD LEVELS DETERMINED BY PARAMETRIC AND STATUTORY CRITERIA

TECHNICAL APPENDIX

Aircraft Activity Threshold Levels Determined by Parametric and Statutory Criteria

In developing the step-by-step air quality assessment process (Section II) and in reviewing airport air quality documentation[1], it was noticed that airport activity was not always at a level that would produce carbon monoxide (CO) concentrations in violation of the national ambient air quality standards. It followed that if activity levels at certain airports were low and the resulting pollutant levels were low relative to ambient standards, considerable time and money could be saved if a threshold concept technique was developed which would screen out the need for further analysis. This perception led to an analysis of pollution from automobile and aircraft sources at general aviation and commercial airports for the purpose of establishing activity threshold levels below which a detailed air quality assessment would not be required.

The analysis procedure involved the following steps:

1. The review of state indirect source regulations.

2. The development of a parametric analysis of concentrations produced by aircraft and other airport sources. This analysis involved the use of the EPA's PAL computer program and the Department of Transportation CALINE 3 models.

---

[1] See Reference 18 in the Annotated Reference List in Section V.

STATE THRESHOLD ANALYSIS

A few states still retain Indirect Source Review (ISR) regulations. Some of these states have established threshold levels below which detailed air quality assessments may be bypassed. These thresholds are based on either parking lot capacity, highway annual daily or hourly traffic volume, airport passengers per year or the number of airport operations. Sample threshold levels for state ISR are summarized in Table A-1.

PARAMETRIC ANALYSIS

General Aviation Airports

Aircraft and automobiles are the two main pollution sources at a general aviation airport, with aircraft being the predominant pollution sources. The EPA PAL model was used in the general aviation airport analysis. The emmissions were considered to originate from aircraft with twin Teledyne/Continental TS10-360C engines. Concentrations were measured at source-receptor distances of 300 and 500 meters for a spectrum of airport activity levels. These distances reflect the range of distances over which the public might first be exposed to significant pollution from aircraft at a general aviation airport.

The wind angle producing the highest concentration was used in the calculation along with a wind speed of one meter per second and a stability class of "D."

These parameters reflect the pollution conditions expected during the hours of the day that an airport would be active. Calculations were performed for the highest polluting mode, takeoff. Results of the dispersion modeling are plotted in Exhibit A-1.

Commercial Airports

The two major carbon monoxide (CO) sources at commercial airports are queuing aircraft that are lined up just prior to takeoff and automobiles that are moving at slow speeds around the terminal. While it is expected that automobiles would be the predominant source impacting pedestrians at a commercial airport, a check was first made to quantify the extent of pollution from aircraft. Emissions from a taxiway queue prior to takeoff was selected for analysis.

Table A-1

Sample of State Threshold Criteria For Indirect Source Review

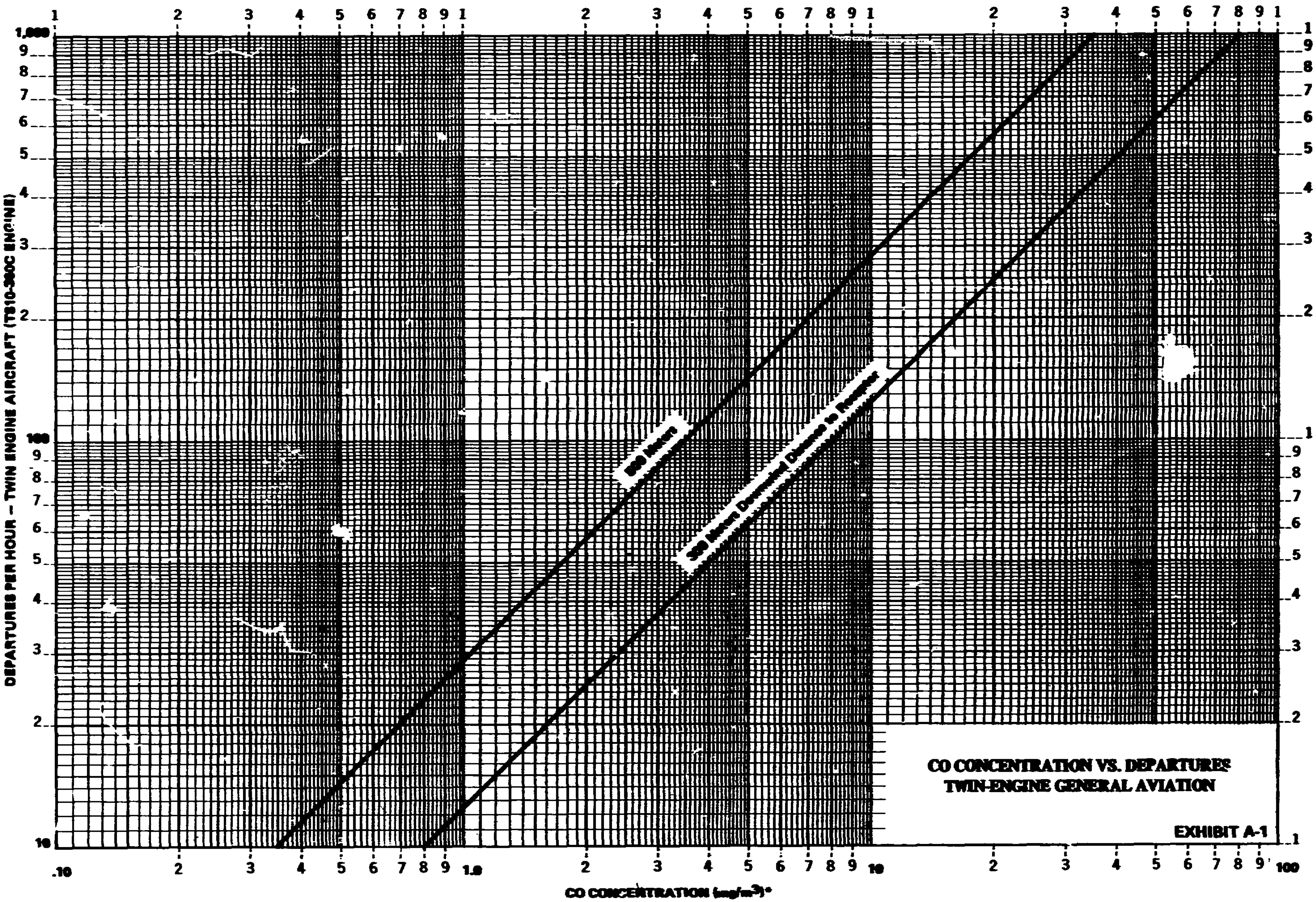
State	Parking Lots	Highways	Airports
Minnesota	2,000 new spaces or increase of 1,000 spaces.	20,000 ADT or increase of 10,000 ADT.	1,000,000 passengers per year-new or modified.
Nebraska	For non-designated SMSA, 2,000 new spaces or increase of 1,000 spaces. Induces 2,000 trips in one hour or 10,000 in eight hours. In designated SMSA, 1,000 new spaces or increase of 500 spaces. Induces 1,000 trips in one hour or 5,000 trips in eight hours.	2,000 one-hour volume or 20,000 ADT or increase of 10,000 ADT.	
New York		20,000 ADT or increase of 10,000 ADT.	
North Carolina			100,000 annual operations or 45 operations in peak hour.

Table A-1—Continued

State	Parking Lots	Highways	Airports
Oregon	1,000 parking spaces new or increase.	50,000 ADT or increase of 25,000 ADT.	50,000 annual operations or increase of 25,000 operations.
Utah	600 new spaces or increase of 350 spaces.		
Wisconsin	In designated SMSA, 1,000 new parking spaces or increase of 500 spaces. For non-designated SMSA, 1,500 new spaces or increase of 750 spaces.	In designated SMSA, 1,200 vehicles in peak hour or increase of 1,200 in peak hour. For non-designated SMSA, 1,800 vehicles in peak hour or increase of 1,800 vehicles in peak hour.	New facilities-50,000 operations/year or 1,000,000 passengers/year. Modified facilities, 50,000 operations/year or 1,000,000 passengers/year.

K+E LOGARITHMIC 2 X 3 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7323



CO CONCENTRATION VS. DEPARTURES
TWIN-ENGINE GENERAL AVIATION

EXHIBIT A-1

* mg/m^3 x .873 = ppm

Seven commercial aircraft that were observed to be queued prior to takeoff at a busy airport were analyzed. Source-receptor distances of 500 and 1,000 meters were selected to reflect the distances at which the general public might first be exposed to these aircraft emissions. The results of this analysis, which was performed with the PAL model for the meteorological conditions described for the general aviation case, show the concentrations from commercial aircraft are between 4 and 14 percent of the one hour NAAQS. These findings are consistent with prior modeling and monitoring data[2] at air carrier airports which shows CO pollutant contributions from commercial aircraft to be low. These findings suggest that for air carrier airports, the basis for air quality threshold evaluation should be directed toward the automobile traffic.

The California Line Source Model (CALINE 3) was employed to analyze automobile pollution. Emission factors for light duty gasoline vehicles were obtained from the MOBILE II computer program.[3] Meteorological assumptions were the same as those used in previous General Aviation Airport analyses and the results of the analysis are parametrically plotted in Exhibit A-2.

THRESHOLD DETERMINATION

Generally, emission sources at an airport which contribute only a small percentage of the national standards (i.e., 10 percent) would probably not require detailed air quality analysis.

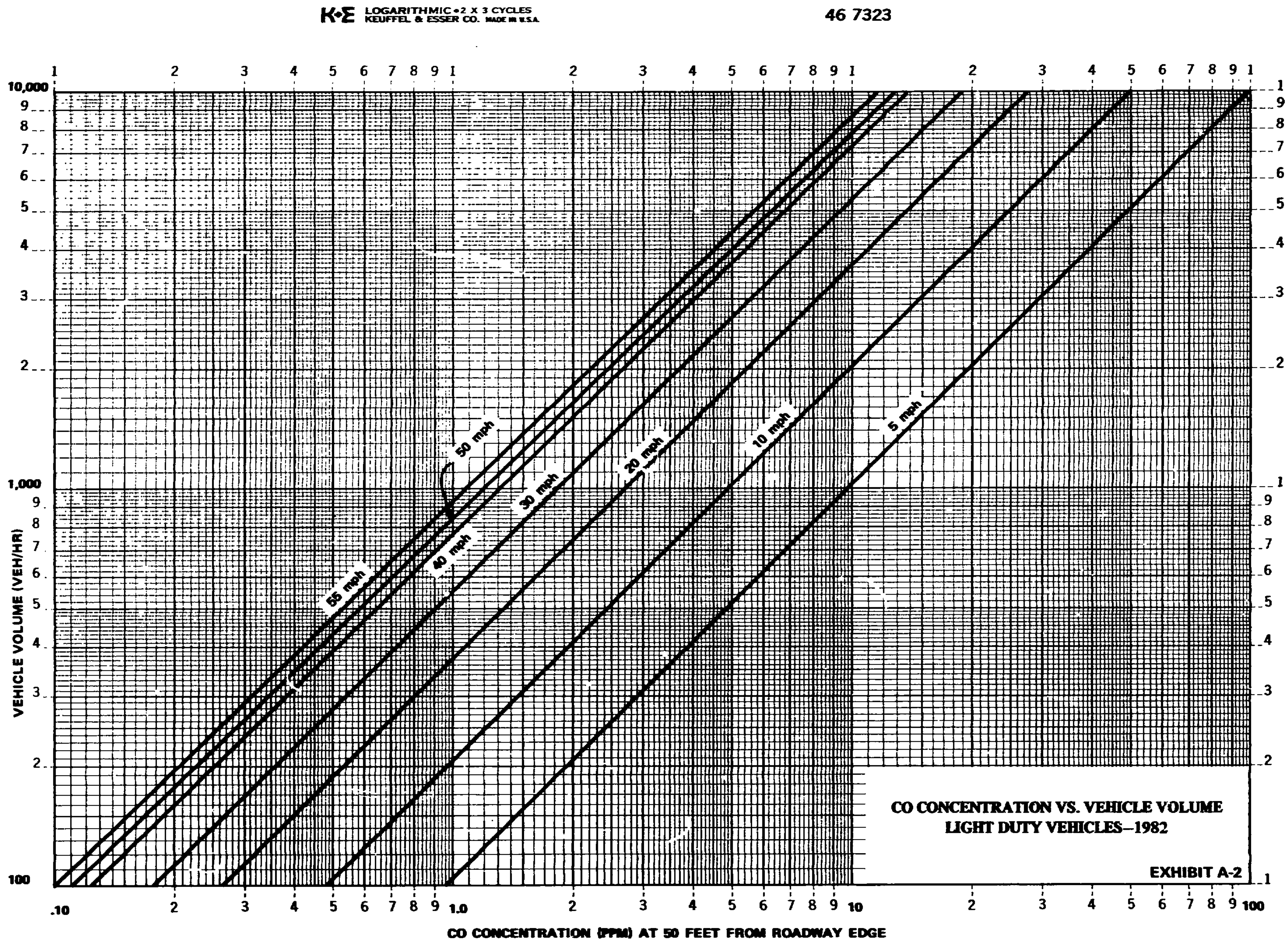
For the general aviation case (Exhibit A-1), 10 percent of the standard would be generated by approximately 50 departures per hour. Assuming the peak-hour general aviation activity to be approximately 20 percent of the total daily activity, then the annual operations (2 x departures) would be:

$$50 \text{ departures} \div 20\% \times 365 \text{ days/year} \times 2 = 182{,}000 \text{ operations/year}$$

or approximately 180,000 annual operations. This level appears in the assessment flow chart in Section II as the non-air carrier threshold for further air quality analysis.

[2] See Reference 18 in the Annotated Reference List in Section V.

[3] See Reference 3 in the Annotated Reference List in Section V.



CO CONCENTRATION VS. VEHICLE VOLUME
LIGHT DUTY VEHICLES—1982

EXHIBIT A-2

For the commercial airport case, Exhibit A-2 shows that approximately 360 arriving vehicles per hour generate an hourly CO concentration of 4.0 mg/m^3 (10 percent of the standard) at a distance of 15 meters (50 feet) from the roadway edge when operating at a congested terminal.

Assuming that peak-hour automobile activity is 10 percent of the total daily traffic at the terminal, and that each vehicle is associated with one enplaning passenger, then the total annual passengers for the facility can be computed as:

> 360 arriving vph (or 360 enplaning passengers per hour) ÷ (10%) x (365 days/year) = 1,314,000 enplanements or approximately 1,300,000 annual enplaned passengers.

Thus the threshold levels established by the parametric analysis are 180,000 operations per year for general aviation aircraft and 1,300,000 enplaned passengers per year for commercial air carrier airports. These operational threshold levels represent existing or projected cumulative totals, not increases. If an improvement project having the potential for air quality impact is proposed at an airport with these levels of activity or projected to have them as a result of the project, then a more detailed air quality assessment for that action may be warranted.

The state threshold criteria are lower than the parametrically developed thresholds (see Summary Table A-2 below).

Table A-2

Comparison of Threshold Criteria

	State Analysis	Parametric Analysis
Passengers/year	1,000,000	2,600,000
Operations/year	50,000 to 100,000	180,000

The state threshold criteria is used in the selection of projects for Indirect Source Review and would have been developed to reflect statewide pollutant conditions, strategies, or problem areas. Therefore these conditions could be expected to be more restrictive and, in fact, appear earlier in the assessment flow chart presented in Section II.

For projects in those states that do not have ISR, the parametric threshold criteria would prevail unless consultation with the state/regional Air Quality Agency revealed further requirements.

☆U.S. GOVERNMENT PRINTING OFFICE: 1983-381-428/2421